SHORT- AND LONG-TERM IMPACT OF A PHYSICAL EXERCISE INTERVENTION ON PHYSICAL CAPACITY AND PERCEIVED PHYSICAL WORK ABILITY AMONG MIDDLE AGED WOMEN

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ABSTRACT
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Only a fifth of the Finnish adult population fulfill the national recommendations for health-enhancing physical activity and 36% experience their work to be physically demanding.

The aim of this study is to investigate the short- and long-term impact of regular progressive leisure time physical activity on physical capacity (maximal oxygen consumption) and on perceived physical work ability among middle aged women.

This study was conducted in cooperation with the UKK-Institute and the material used is based on the institute's MELLI-study which aim was to assess the effect of aerobic training on quality of life in a six months long randomized controlled trial. The original study included 176 women with menopausal symptoms. The women were randomized into an intervention and a control group. This study included those 62 women who worked part- or fulltime and had data regarding their perceived physical work ability and maximal oxygen consumption (VO_2max) four years after the randomized controlled trial. It was hypothesized that an increase in physical exercise during leisure time will increase the physical capacity and physical work ability of the women.

The physical exercise trial instructed the intervention group to practice leisure time physical activity 4 x 50 minutes per week (of which two times had to be walking or Nordic walking) and to take part in lectures about health and exercise. The intervention and control group reported in a questionnaire their perceived physical work ability. Maximal oxygen consumption was measured with UKK-Institute's 2 km walk test for both groups at baseline, immediately after and four-years after the intervention.

After the six months of physical exercise the intervention group increased the maximal oxygen consumption more than the control group, the changes between the groups where almost statistically significant ($p=0.057$). After four years the VO_2max had decreased and where on about the same level in both groups. There were no statistically significant changes in perceived physical work ability between the groups after neither six months nor after four years. It was concluded that the physical exercise intervention had only minor short-term effects on physical capacity but no long-term effects on either physical capacity nor physical work ability of the middle aged women.

Keywords: Physical functioning, maximal oxygen consumption, perceived physical work ability, middle aged women, randomized controlled trial

CONTENT

ILLUSTRATIONS

FOREWORDS

This Master's thesis is a continuum on a bachelor's thesis published in Swedish language by the same author in 2014 [1]. The previous thesis studied the *"Effects of a physical activity intervention on physical function and perceived work-related physical strain among women in menopause"*. The conclusion was that a six months long physical exercise intervention improved physical fitness among women in menopause but did not significantly decrease the perceived physical work strain (Nygård, 2014). This thesis is a four-year follow-up and uses the same raw data to study the short- and long-term effect of the physical activity intervention. The structure and theoretical framework are partly be the same (in a reproduced format) as in the study published in 2014. However, the point of view, sample size and study variables are to a certain extent different. The previous study concentrated on work-related physical strain and this study's focus is on perceived physical work ability and therefore are the outcomes not automatically comparable.

[1] Nygård, M. 2014. *Inverkan av en motionsintervention på den fysiska funktionsförmågan och den upplevda fysiska arbetsbelastningen hos kvinnor i menopaus.* Bachelor's thesis, Arcada University of Applied Sciences. http://urn.fi/URN:NBN:fi:amk-201402062083.

1 INTRODUCTION

Physical inactivity is becoming an increasing burden in today's society. The yearly costs have been estimated to be 3.2-7.5 billion euros and the sum will continue to grow due to aging of the population and prevalence of diseases. The importance of converting immobility to movement has become more crucial than ever before. (Vasankari et al. 2018.)

The health benefits that physical activity has have been proven to be many, for example better metabolism, stronger bone mass and better oxygen uptake (Fogelholm et al. 2011). Despite all the health benefits, adults in Finland are living a sedentary lifestyle where they sit or lie down most of the active hours of the day (Husu et al. 2018).

A recent publication (Husu et al. 2018) indicates that only a fifth of the adult population fulfill the national recommendations for health-enhancing physical activity (moderate activity 2 h 30 min/week or vigorous activity 1 h 15 min/week). Middle aged women are in general slightly more active than younger women, or men in any age. Another study shows similarly that in 2010, half of the Finnish working population fulfilled the national recommendations and a fifth were living a sedentary lifestyle. Lengthening of working carriers, which is a national goal in Finland (The Government of Finland, Ministry of Finance 2011 & 2016), will require increased levels in leisure-time physical activity to maintain health and work ability; the relation between work demands and personal resources (Työturvallisuuskeskus 2013). (Husu et al. 2011.)

According to a recent study (Mähönen 2017, 89-94) experienced 36% of Finnish working adults their work physically demanding. This might be a result of more service minded work tasks were for example nursing and caring has remained physically demanding despite that information technology has become more common in work-related tasks. Another explanation might be poor exercise habits, insufficient recovery from strain and thereby increased levels of stress. (Lehto et al. 2008, 63-66.)

The importance of studying how physical acitivity can affect work ability is a societally important topic. One of the governmental aims is that working aged individuals should be able to stay active in working life for as long as possible (The Government of Finland, Ministry of Finance 2011 & 2016).

Due to biological factors physical capacity decreases approximately 10% every decade after the age of 25 years (Keskinen et al. 2010, 53) but the decrease can be slowed down with an increased amount of physical activity and thereby a person's physical functioning could be maintained for a longer time (Michalsik et al. 2004, 59). With the combination of the linear decrease of functional capacity and unchanged work tasks, the work at some point will become too demanding, and the worker will experience work-related strain. In the worst case this phenomenon could result in the worker being incapable to work. By improving functional ability, like physical capacity, could the individual's resources maintain good in proportion to the demands of the work tasks. If the demands are not exceeding the functional ability it can result in a possibility of a prolonged working career. (Ilmarinen 2006, 49.)

A study (Pohjonen 2001) reported that especially middle aged workers benefit from physical exercise with work-related outcomes. Chronic diseases and poor cardiorespiratory fitness are factors that may decrease an individual's work ability and result in work-related strain. Work ability among women generally decreases more rapidly than among men and the differences can especially be seen during the transition age of menopause (Geukes et al. 2012). It is important to study how the functional ability could be improved, and thereby support an individual's capability to work; promote a good work ability.

This study investigates the impact of a six-month physical exercise intervention on physical capacity (VO_2max) and thereby on perceived physical work ability immediately and four years after the intervention. The suitable amount and the benefits of physical exercise for promoting a good functional capacity are well known, but there is not enough knowledge about the association of physical exercise and work ability especially among middle aged women (Rutanen 2017).

Data for this study is collected by the UKK-Institute for their MELLI-study. MELLI stands for the Finnish words for "*menopaussi, elintavat ja liikunta"*, which can be translated to menopause, lifestyle and exercise. The original study was carried out between 2009-2013 in cooperation with researchers from the UKK-Institute, the National institute for health and welfare, the University of Tampere, Helsinki University Hospital and Tampere University

Hospital. The purpose of the MELLI-study was to research the effect of regular physical exercise on menopause related symptoms and perceived quality of life by using a randomized controlled trial. The study has been financed by the Ministry of education, the Academy of Finland, Yrjö Johansson's foundation, Juha Vainio's foundation and the Hospital district of Pirkanmaa. (Luoto et al. 2012.)

2 PHYSICAL ACTIVITY AND WORK ABILITY IN THE SOCIETY

In a welfare state like Finland, working aged individuals have a huge impact on the national economy. A sufficiently high employment rate is essential for financing the public economy. This is one reason why the governmental aim is that working aged individuals should be able to stay active in working life for as long as possible (The Government of Finland, Ministry of Finance 2011 & 2016). The effect of leisure time physical activity on work-related variables have been previously studied to a certain extent (Smolander et al. 2000; Penedo et al. 2005; Ilmarinen 2006; Rutanen et al. 2014). However, the studies have mainly focused on topics such as sick leave, stress and job satisfaction. Some studies have shown positive changes in physical functioning (Pohjonen 2001; Smolander et al. 2000) as well as positive improvements in work ability in general (Rutanen 2017) after a physical exercise intervention. There is only a scarce amount of more specific studies about effects of leisure-time physical activity on physical work ability related variables.

Women’s input in a productive public economy becomes year after year more important (Geukes et al. 2016). In 2017, there were over two million working aged women (age 15-74, definition by Statistics Finland) in Finland, of which over 700 000 are of the age between 45-64. The proportion of women over 45 years is greater in comparison to younger age groups (Statistics Finland 2017) and this demographic change is increasing yearly the age dependency ratio, that describes the size of population outside of the workforce (age 0-14, 65+) in comparison to the productive workforce (15-64) (Ilmarinen 2001). The aging of the population, and hence increasement of the age dependency ratio, is causing severe problems in for example increased expenditures for a welfare state (Ilmarinen 2001; Meier et al. 2010).

In a woman’s life there might occur emotional, social and physical changes in midlife caused by menopause (Geukes et al. 2012). Studies (Griffiths et al. 2013; Geukes et al. 2012; Woods et al. 2011) show that menopausal women experience several symptoms during work, for example depression, low self-confidence, fatigue and poor concentration. These symptoms have a negative effect on work ability and therefore increase the risk of sickness absence.

Up to 80% of women in menopause experience some symptoms (Freeman et al. 2007). When comparing the percentages to the number of women in the age of 45-64 years, this means that up to half a million women in Finland experience menopause related symptoms. According to statistics, an average of 73.8% of women between 45-64 years were active in working life in 2017. This leaves over 400 000 women who might experience menopause related symptoms and are in a risk for lower work ability (calculated from Official Statistics of Finland 2018). If the symptoms and other distractions could be mitigated, the work ability of those middle aged women would maintain or even improve during menopause.

During menopause, there is a slight difference in work ability between women and men. The gender-specific difference stabilizes in older age (Tuomi et al. 1997), which may indicate that women's work ability in midlife is affected by menopause (Geukes et al. 2012). Other factors that might affect this gender-specific difference are for example level of education, number of working hours, duties outside of work and marital status (Gould et al. 2008; van den Berg et al. 2009).

A study by Tavakoli-Fard (2016) indicates that type of work plays a role in work ability. Female shift workers had a worse work ability than non-shift workers. In the same study, a minor correlation between the work ability and the age of female workers was seen. Women of the age above 40 years reported a lower work ability than younger women. However, getting older does not automatically mean that there would be a decrease in work ability (Gould et al. 2008). A Finnish study indicated that about half of the older workers in a sample of municipal employees managed to maintain their work ability for more than 10 years during midlife. Nevertheless, major individual variation in work ability could be seen when people got older. (Tuomi et al. 1997.)

Studies (Husu et al. 2014; Haapala et al. 2016) show that individuals with a higher education fill the recommendations of health enhancing physical activity better than the ones with less years of education. In Finland, the national recommendations (moderate activity 2 h 30 min/week or vigorous activity 1 h 15 min/week) are described in a physical activity chart published by the UKK-Institute (Figure 1). Haapala (2016) studied the changes in the amount of practiced physical activity during leisure-time between individuals with different educational levels between years 2000-2011. The study showed that high educated individuals were the most active and the difference to the individuals with lower education grew during a 11 years follow-up. However, the individuals with a lower education level sit less during the working day than the ones with a high education. This is the other way around on leisure time when the ones with a lower level education are more sedentary. (Husu et al. 2014.) Thus, the relation between educational level and the total amount of practiced physical activity is important to study since the individuals who fulfil the recommendations of health enhancing physical activity during work do not necessarily need to increase as much the amount of physical activity in their leisure time (Haapala et al. 2016).

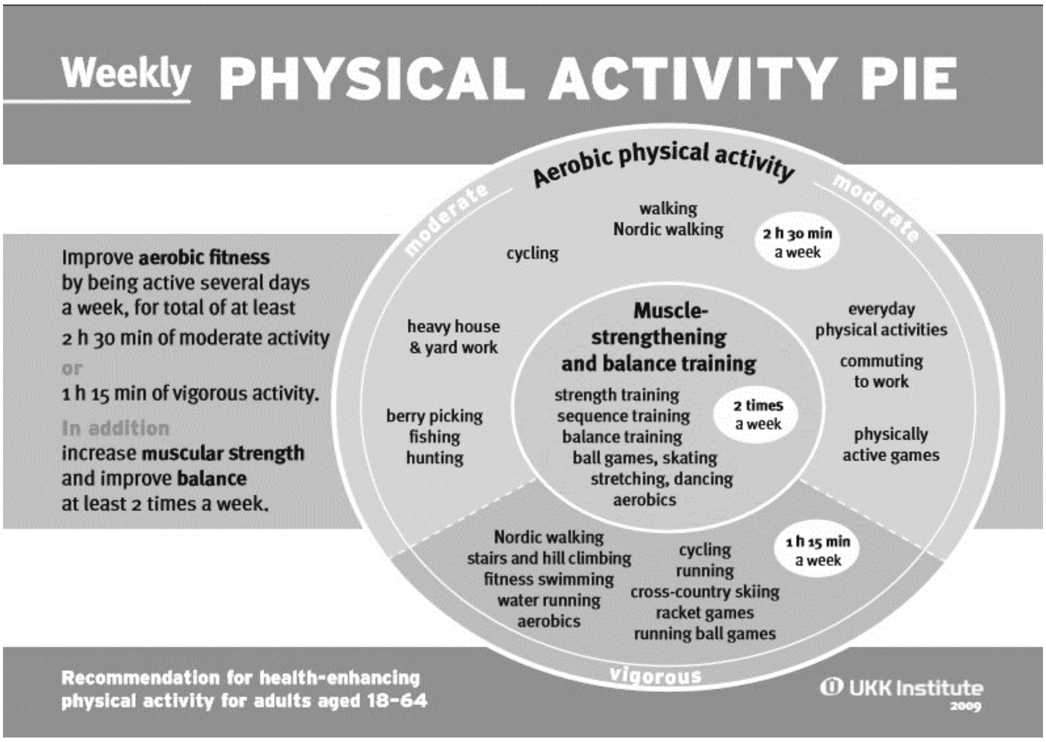

FIGURE 1. Recommendations for health-enhancing physical activity; adults aged 18-64 (UKK-Institute 2009).

Besides of level of education, the residential area has been shown to have an impact on the physical activity level in Sweden. The individuals living in a residential area with lower socioeconomic status (position in society affected by factors like education, income and/or occupation) were more likely not practicing enough moderate to vigorous physical activity. (Lindgren et al. 2016.) Differences between residential areas might thereby lead to social inequalities in health and should be noticed within policy making and activities improving public health (Lindgren et al. 2016; Sugiyama et al. 2015).

The societal costs of diseases caused by sedentary lifestyles and poor physical fitness are not easy to calculate. The costs usually consist of direct costs in health care, but there are also indirect costs like loss of productivity, sickness absence and lower tax incomes for the state. A report published by Prime Minister´s Office in spring 2018 shows that the yearly costs for a sedentary lifestyle in Finland are: disease related costs for healthcare 1,5– 4,4 billion euros, loss of tax incomes 1,4–2,8 billion euros and unemployment allowance about 30–60 million euros. These numbers are expected to grow by 58% by 2040. (Vasankari et al. 2018.)

With an aging population, where the balance of young and older workers is shifting (Statistics Finland 2017), it becomes essential to emphasize the importance of the maintenance and promotion of work ability. As mentioned in the beginning of this chapter, the labor force that is available will affect the funding for a welfare state’s social security. Therefore, good work ability is an essential societal question. (Gould et al. 2008.) This study aims to discuss how perceived work ability could be promoted with physical exercise in a vulnerable group of women in their midlife.

3 DEFINITION OF CONCEPTS

This chapter provides an overview of the concepts and theories that builds the basis of this study and supports the analysis of the findings.

3.1 Physical capacity

Physical, psychological, cognitive and social qualities in respect to our daily tasks, expectations, leisure activities and adversities are described by a wide concept called functional capacity. A good functional capacity supports individuals to live an active lifestyle and perform well so that their goals can be reached throughout the lifespan. Functional capacity can be seen as a resource of health and thereby a way to enhance for example work ability. (Ilmarinen 2006, 117; Helin 2000, 15-16.)

The World Health Organization (WHO) published in 2001 an *International Classification of Functioning, Disability and Health* (ICF) with the aim to have a framework for measuring health and disability at both individual and population levels (Figure 2). The WHO's classification takes into consideration the interaction between every individual's health condition and personal environment. The ICF divides functional capacity into two parts; functioning and disabilities (part 1) and contextual factors (part 2). Part 1 includes factors like physiological and psychological functions, anatomy, daily performances and participation in different life situations. Part 2 covers personal and environmental factors like policies, technologies and attitudes. Personal factors, like age, sex and education, are not classified due to their broad variation. (World health organization 2013, 5-8; Vuori et al. 2013, 171.)

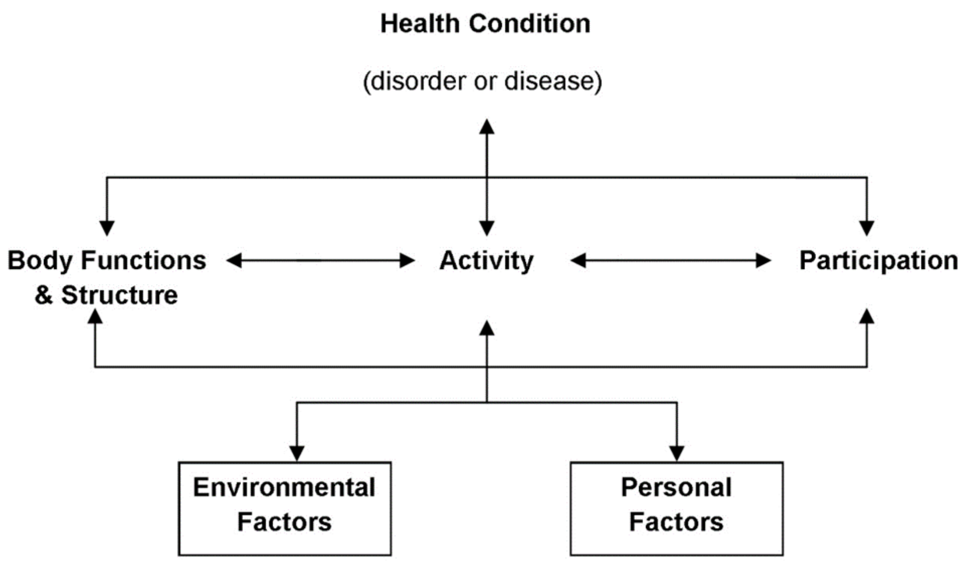

FIGURE 2. International Classification of Functioning, Disability and Health (ICF) (WHO 2001).

In this thesis, the focus is on part 1; the physical, psychological and social functioning that all play an important role in making the individual a strong entirety. More specific, the main concentration will be on the physical aspect of functional capacity. The environmental and personal factors will be only slightly touched in the discussion.

Work-related psychological functioning is defined as an individual's capability to reach personal goals. Accomplishing goals results in a feeling of satisfaction when personal needs are filled. (Matikainen et al. 1995, 123.) Psychological functioning includes also an individual's life management skills, in other words how well one is capable to handle different moments in life. Self-knowledge and -respect, emotional balance, social skills and other personal resources are factors that support a good psychological health. The difference between the psychological and cognitive parts is that the cognitive functioning comprises more detailed qualities that bring strength to the psychological health. These qualities are for example learning, memory, problem solving and concentration. (National Institute for health and welfare 2018; Matikainen et al. 1995, 123-124.) Changes at workplace, stress and too high expectations have a negative impact on psychological functioning and might lead to mental disorders like depression or anxiety (Matikainen et al. 1995, 125-128).

Social functioning describes an individual's possibilities to spend time with other individuals. Factors that affect the social functioning are for example relations to family and friends, ability to express oneself, social qualities and way of living. At work, it is important to feel mutual respect and a sense of coherence with the other employees and the management team. (National Institute for health and welfare 2018; Matikainen et al. 1995, 124.)

Physical functioning, that is a main variable in this thesis, includes qualities like balance, coordination, reactivity, agility, strength and endurance. Human beings need a proper physical functioning to be able to complete the basic tasks like eating and walking, but also for more requiring activities like running, skiing and cycling. Limitations in the physical functioning require adapting of personal resources and possibly even external help. (Vuori 2013, 187-190.)

Being physically active has a holistic positive impact on health and physical functioning, and promotes our psychological, cognitive and social features. Physical exercise stimulates the activity of neurotransmitters, like the hormones dopamine and serotonin, which contribute to our mental wellbeing, improve stress management and allows us to think clearer in social conflicts. (Nyblom 2009; Borer 2003.) Promotion of psychological health has a positive impact on an individual by improving the capacity to recover from psychological strain. However, diminishing of physical functioning has a negative impact on both psychological and social functioning. Physical exercise can be a tool to keep these three features in balance and therefore lead to the possibility of maintaining work ability and diminish the risk of work-related strain. Since these features are in constant interaction with each other, becomes the importance of the functioning between the features more significant the older people get. (Vuori, 2010; Penedo et al. 2005.)

For humans, a central factor in the physical functioning is the transport and use of oxygen. To the complex system belongs the respiratory tract, heart, veins, muscles and oxygen consuming cells. The interaction between these defines our capacity to accomplish dynamic physical performance. When talking about physical fitness or condition it is often referred to the functioning of oxygen uptake and the use of it, the aerobic effect. The most commonly used measure of this effect is the maximal oxygen consumption often shorten to VO_2max (v=volume, O_2= oxygen, max= maximal), that describes the body’s capacity to use oxygen under a maximal performance. (Vuori 2013, 187; Matikainen et al. 1995, 101-107.) In other words, the maximal oxygen consumption consists of two parts; the muscles capacity to use oxygen in the form of energy and the capacity of the circulation systems to transport oxygen to the muscle cells (Keskinen et al. 2010, 52).

In physical exercise where the person is moving his own body, for example running, the value of VO_2max is usually presented in how big the uptake of oxygen per minute is per kilograms of body weight (ml oxygen/min/kg). In sports where the body weight is not affecting as strongly the performance is the VO_2max value given as liters of oxygen per minute (l oxygen/min). These values, also known as test values, are relevant to use when comparing physiological changes before and after a training period. The test value describes the fitness level of a person in comparison to reference values (Table 1) among both trained and untrained individuals. However, the test values cannot be compared to other individuals since VO_2max is affected by weight and height. A small person has a smaller VO_2max-value than a bigger person because of the weight. Other significant factors that affect the test value are sex and age. (Michalsik et al. 2004, 56–59.)

TABLE 1. Classification of VO_2max according to Shvartz and Reibold (Keskinen et al. 2010, 276)

Age	**VO_2max (ml/kg/min)**						
	Very low	Low	Fair	Moderate	Good	Very good	Elite
45-49	< 21	21-23	24-27	28-31	32-35	36-38	> 38
50-54	< 19	19-22	23-25	26-29	30-32	33-36	> 36
55-59	< 18	18-20	21-23	24-27	28-30	31-33	> 33
60-65	< 16	16-18	19-21	22-24	25-27	28-30	> 30

Women have in general 15-30% lower VO_2max values than men in the same age because of biological factors like smaller heart, less amount of blood with lower content of hemoglobin and a different body consistence (women have more adipose tissue) (Fogelholm et al. 2011, 105; Michalsik et al. 2004, 56–59).

The maximal oxygen consumption has been proven to change significantly during the life span. In average, the VO_2max-value decreases 1% every year among both women and men after turning 25 years (Keskinen et al. 2010, 53). This change can partly be explained with biological factors such as diminishing of the frequency of the heart rate, but a more significant factor is a more inactive lifestyle. It is possible to slow down the decrease or even turn it into an increase of the VO_2max-value with regular training and an active lifestyle. Thereby, older active individuals might have a significantly higher VO_2max-value than young sedentary people. (Michalsik et al. 2004, 59.)

There are different methods to measure the maximal oxygen consumption. The methods can be divided into three main groups; direct tests, indirect tests and field tests. The difference between these tests is the equipment, space, budget and time that is for use. Also, the different types of tests have a different accuracy. VO_2max is very exercise specific and that is why it has a significant role what type of test is chosen to measure the values. The most essential factor that affects the value is the amount of working muscles. The more muscles that are active the higher will the VO_2max-value rise. As an example, can be named Nordic walking, where the amount of active muscles is higher than in running and thereby is a higher VO_2max-value reached. (Keskinen et al. 2010, 51–117.)

3.2 Work ability

We use a significant part of our awake hours for working, hence, work is one central element in a human’s life (Mähönen 2017, 10). To be able to work has versatile benefits. Beside of being a source of financial income, work plays an important role in life management, social interaction and time management. Working allows self-actualization and development of skills, and an employee with high job satisfaction results in enhancement of health and well-being. (Bowling et al. 2010; Airio et al. 2013, 44-46.)

The description of work ability has changed during the past decades in relation with the development of the society. Earlier, when more physical works tasks were executed, good work ability was a result of a good physical condition. Sickness equaled poor work ability according to the so-called medical perspective. Today, work ability is perceived as a more holistic entirety, built of the balance between an individual’s resources and work requirements. (Gould et al. 2008, 17-19; Ilmarinen 2006, 79.) An individual’s work ability is therefore a combination of different components:

1. Health and functional capacities
2. Competence
3. Values, attitudes and motivation
4. Work, work community and leadership

(Ilmarinen 2006, 79-80.)

Work ability changes during the lifespan. The needs and interests of employees varies depending on the life situation and therefore is work ability about constantly finding a balance between personal resources and work requirements. (Ilmarinen 2009.)

The Work ability house, created by Ilmarinen (2006), describes the different components of modern work ability based on studies that have researched which factors impact the individual capacity to complete daily work tasks. The floors in the work ability house (Figure 3) build on each other and this means that work ability will be harmed if one or more of the floors are defective. The 1st floor, which consists of health and functional capacities, is the basis for the whole work ability house. That is why changes in health and functional capacities will reflect all the other floors and thereby also the work ability. Decrease in functional capacities will lead to a decline in work ability but an improvement will enable development of work ability. (Finnish Institute of Occupational Health; Ilmarinen 2006, 79-81.)

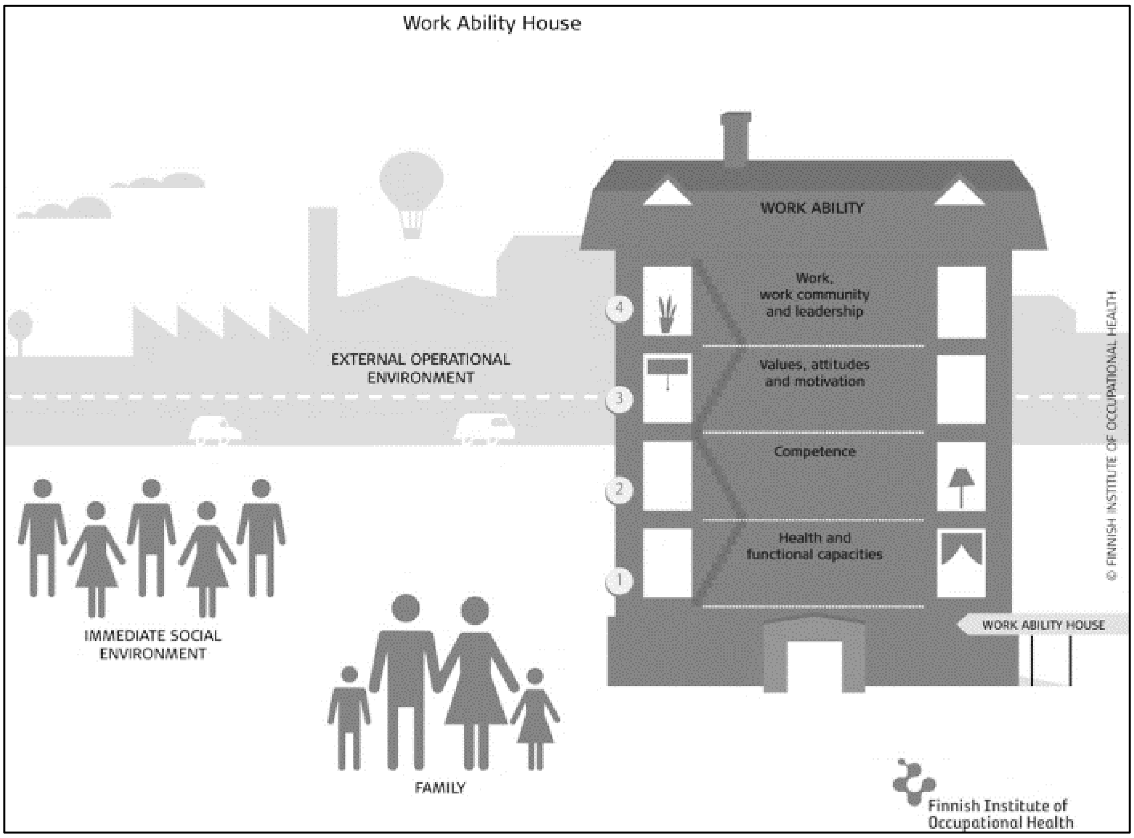

FIGURE 3. Work ability house (Finnish Institute of Occupational Health).

An individual is also affected by external factors like family and social environment. Thereby is the responsibility of a good work ability divided between the individual, the work environment and the society. (Finnish Institute of Occupational Health; Ilmarinen 2006.) In the work ability house, an important and heavy component is the 4th floor where the responsibility of an individual's work ability is also on the workplace and its community. This floor could in the worst scenario press down or collapse on the other floors and therefore should the leadership model include active steps of promoting an employee's work ability. (Finnish Institute of Occupational Health; Ilmarinen 2006, 79-81.) Examples of work ability promoting activities are the influences of better ergonomics, precise trainings and individually tailored solutions to ease workloads. These activities, and many more, will become more important the older we get. (Ilmarinen 2006, 17.) The past decades, work communities have begun to actively engage health promotive activities into work days. According to a longitudinal study (Mähönen 2017) has there been an increase in involvement of workplaces in promotion of the employer's health, fitness and lifestyle from 1998 to 2008, but after 2008 has the involvement slightly diminished. Of the ones that answered the study survey in 2016 were 46% working in a workplace that had supported the employee's health on some level, and 18% had experienced a lot of support. The remaining fair third had not experienced any notable health promotion activities from their workplace.

A strong basis for good work ability is built by investing in health and functional capacities. Good work ability requires a certain amount of personal resources in relation to individual work requirements. When we get older will our physical functioning constantly decrease (Keskinen et al. 2010, 53) and if our work tasks maintain the same can the decrease also be seen in our personal resources that we have for usage. This can result with work tasks exceeding the functional capacity (Figure 4) and the job become harder to execute, leading to fatigue, overload and eventually to inability to work. Even some life situations and diseases can lead to that work feels temporarily more demanding. It is possible to maintain the individual resources by promoting functional capacity and/or diminishing the work tasks. This way the workload will not exceed our resources and we can stay longer active in working life (Figure 4, right). (Ilmarinen 2006, 49.) This is even an important social political question. It was defined as one aim in the Programme of the Finnish Government that all workers in Finland should have the possibility to strive after more years in their career (The Government of Finland, Ministry of Finance 2011 & 2016).

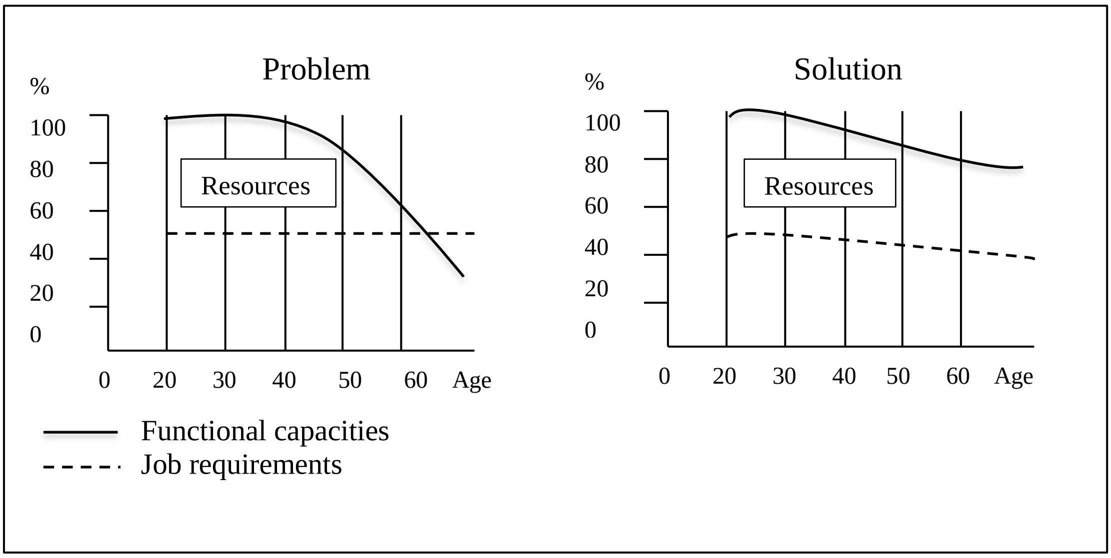

FIGURE 4. Relation between functional capacities and job requirements (modified from Ilmarinen 2006).

Physical, psychological and social functioning form together with health the basis for good work ability. A working day could be defined as a period which length and intensity enables both physical and psychological recovery before the next working day (Lindström et al. 2003, 7). In other words, enough of leisure time and rest is needed before the next working day. Insufficient recovery can lead to reduced work ability, fatigue and pain in the musculoskeletal system. One important factor for recovery is sleep which is positively affected by regular physical exercise. (Ilmarinen 2006; Matikainen et al. 1995.)

As a result of the interaction between the individual and her workplace becomes work-related strain. This strain can be positive and motivating, but it can also be a risk factor for the health and wellbeing of the employee. The negative work-related strain is a state where the physical and psychological resources are not enough to complete the work tasks. Factors that affect are physical environment, ergonomics, working hours and psychosocial factors. (Ilmarinen 2006, 117-119; Lindström et al. 2003, 9–11; Gould et al. 2008.)

An individual's work-related strain can be described with a model of physical work strain and the employee's level of strain (Figure 5). This so called "Stress-Strain" model was created by Selye in the 1950's. (Lindström et al. 2003, 13; Louhevaara et al. 1995.) The model emphasises that the workload ("stress", like physical work tasks) is modified during the whole lifespan according to the individual's personal features like sex, age, fitness, health status, life situation and functional capacity. These personal factors in a combination with the work tasks affect how physically overloaded the employee is, so called level of "strain". The employee's strain can be for example disturbance in the musculoskeletal, cardiovascular or respiratory system. By enhancing the individual chracteristics with for example an active lifestyle can the same work tasks load the employee less. (Lindström et al. 2003, 13.)

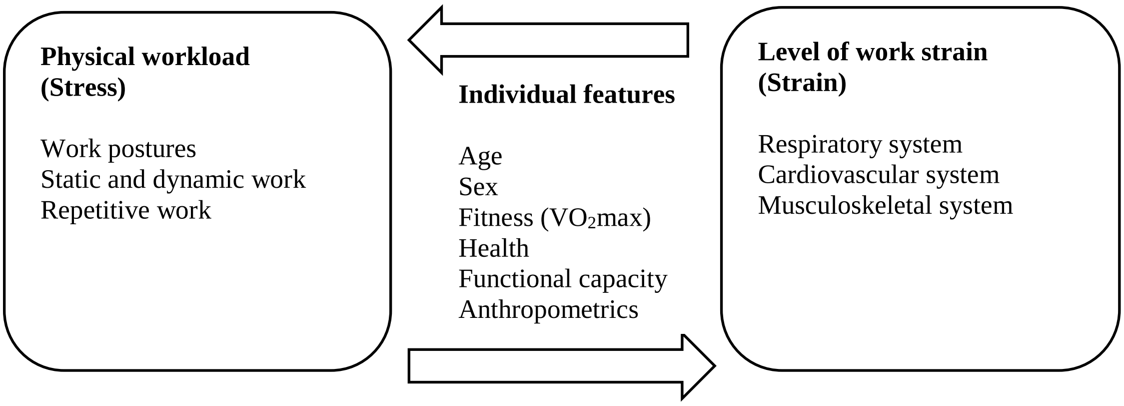

FIGURE 5. Physical workload and level of work strain (modified from Lindström et al. 2003).

The stress-strain model emphasasis that individual features, like functional capacity, should be taken into consideration when modifying the workload according to the strain of the person. Physical workload describes a task that is heavy for the body as a result of handling strain, staying in isometric or not so ergonomic positions and continuous repetition of tasks. These often lead to back and neck pain. Even too little or monotonic workload like sedentary work, can lead to perceived pain. (Lindström et al. 2003, 13-14.)

When the body is physically in good condition it can bare more strain since a blood circulation and metabolism that are in a good shape can handle loads well. However, for example diseases like atherosclerosis can cause hypoxia (oxygen deprivation) in the heart muscles during physically heavy work. If the workload increases constantly 30-40% over the maximal cardiorespiratory functioning capacity is the employee’s resources going to waste and one’s health is harmed. (Lindström et al. 2003.)

Psychological workload is caused when the requirements of the work is not in balance with the individual resources. These so-called psychosocial demands can be for example insufficient cognitive competences, lack of time, work atmosphere and conflicts between the employer or colleagues. Long-term psychological stress can cause various physiological symptoms like sweating, tachycardia (irregular heartbeats), dizziness and abdominal pain. Even depression, exhaustion and lack of motivation can be experienced. In the worst case can the symptoms be so severe that the employee is incapable to work or must retire earlier than expected. (Ilmarinen 2006; Lindström et al. 2003; Matikainen et al. 1995, 128.)

It is possible to avoid negative work-related strain by considering the individual’s physical, psychological and social resources, and to balance them with the work tasks (Lindström et al. 2003, 13-14). This way can good work ability be promoted (Ilmarinen 2006, 49).

3.3 Menopause

In midlife (around 45-55 years) usually occurs a meaningful period in a woman’s life; the menopausal transition. It starts when the ovulation and menstruation stop, in other words when there is not egg cells left and reproduction is no longer possible. This change in the body causes a disorder in the hormone balance and thereby several symptoms like hot flushes, night sweats, mood swings or anxiety. (Sand et al. 2006, 516; Freeman et al. 2007; Luoto et al. 2012.)

Menopause does not necessary cause gaining of weight, but the diminishing production of estrogen leads to increased amounts of adipose tissue around the internal organs. This results in an increased risk of cardiovascular diseases. (Fogelholm et al. 2011, 108.) It is recommended to exercise at least 30 minutes every day during menopause; this can lower the risk to get sick by 12-40% (Fogelholm et al. 2006, 190). Even the bone density is reducing in this age and exercising has been proved (Vuori et al. 2013) to be an excellent way to slow it down and thereby decrease the risk of osteoporosis. Other positive effects of regular exercise are psychological factors like better mood and possible cure of depression (Fogelholm et al. 2006, 191).

Menopause might affect a middle aged woman’s perceived quality of life, and since up to 80% of women experience some symptoms (Freeman et al. 2007; Luoto et al. 2012), cannot the ability to maintain work ability be taken for granted. The symptoms last at least for four years, but some women experience them for more than a decade (Freeman et al. 2007). Physical exercise has shown to positively affect symptoms like irritation, mood swings and night-time sweating (Moilanen et al. 2012) and thereby may a physically more active lifestyle positively affect the perceived work-related strain (Rutanen et al. 2014).

Middle aged women, and middle aged men too, represent great work-related strengths and benefits in comparison to younger employees. For example, great work experience is seen as wisdom, commitment, loyalty, and more holistic understanding of and carefulness in work tasks (Ilmarinen 2001).

4 RESEARCH QUESTIONS AND METHODOLOGY

The aim of this study is to investigate the short- and long-term impact of regular leisure time physical exercise on physical capacity (VO_2max) and on perceived physical work ability among middle aged women. It is important to understand if the middle aged women could possible improve their perceived work ability with physical exercise since a majority of women in that life phase experience some symptoms caused by menopause (Freeman et al. 2007). This improvement would in the best-case lead to less days of sickness absence, higher productivity and less costs for the state.

Research question:

What are the short (6 months) and long-term (4 years) impacts of a six-month long physical exercise intervention on physical capacity (VO_2max) and on perceived physical work ability among middle aged women?

4.1 Study design

The study design that was used for the intervention was a Randomized Controlled Trial (RCT). A randomized controlled trial has an experimental design, meaning that the study uses an experiment or intervention to research the effect of an action on one group in comparison to another during the same period of time. This type of study needs to include the following central criteria:

1. Comparable
2. Randomized
3. Data from a certain period
4. Active manipulation of the intervention group

(Jacobsen 2007, 79-84.)

4.2 Participants and data

Participants were selected through a local newspaper announcement in 2008. 351 women were screened through telephone interviews to fill study criteria (Table 2). The original study included 176 women with menopausal symptoms who wanted voluntarily to be a part of the study. The women were divided through computer randomization into two equally sized groups, an intervention and a control group. During the trial there was 22 drop-outs of which 14 were in the intervention group and 8 in the control group.

TABLE 2. Inclusion criteria for the sample

Criteria
Age 40-63
BMI under 35km/m²
Daily menopausal symptoms
6-36 months since last menstruation
No hormone replacement therapy during the last 3 months
Sedentary lifestyle
No disease that prevents exercise

This study includes the 62 women who filled, in addition to the ones mentioned above, the following criteria at the four-year follow-up; data on maximal oxygen consumption, data on perceived work ability in terms of the physical demands of work (see Appendix 1: question 17), worked full- or part-time and had data on BMI values. The process of selecting the sample for this study is described in Figure 6.

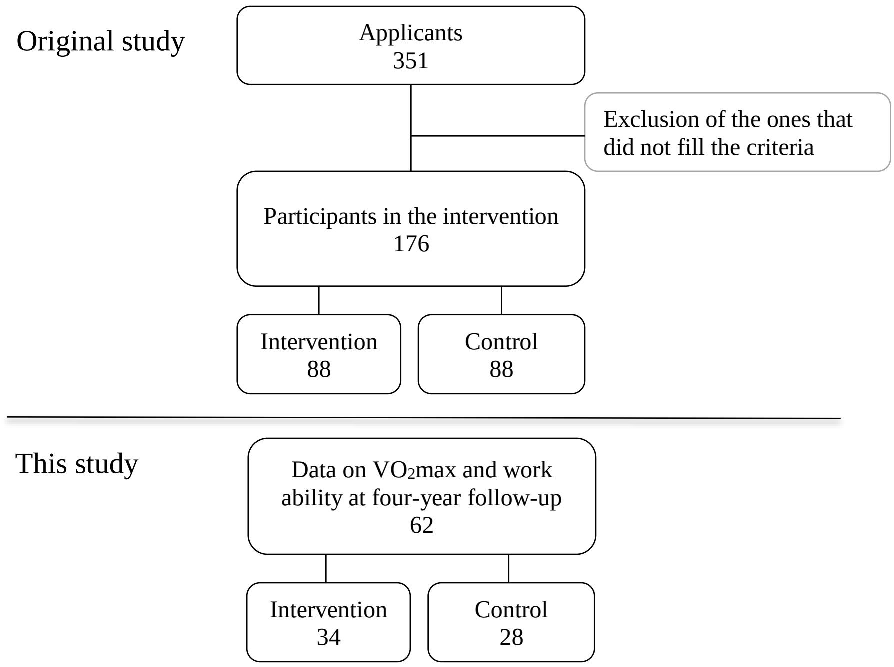

FIGURE 6. Division of sample for the study

The six months long trial instructed the participants to answer questions about their health, nutrition, medication, disorders and perceived work ability in questionnaires before, after and four-years after the intervention.

The intervention group was instructed to:

1) Exercise progressively 4 x 50 minutes per week (of which two times had to be walking or Nordic walking). Intensity between 64-80% of estimated maximum heart rate.
2) Participate 1-2 times per month in 60-75 minutes long lectures about general health and exercise. Lectures were given by the researcher group.
3) Use a heart rate monitor (Suunto®; Memory Belt) for measuring the intensity of the exercises.

UKK-Institute provided instructed fitness classes 1-2 times a week for the intervention group during the trial. The control group was advised to continue their normal lifestyle apart from the encouragement to participate monthly in lectures about health and exercise provided by the research group.

4.2.1 Data collection

All the participants filled a questionnaire before, six months and four years after the intervention. Included factors were age, sex, education, work and exercise habits. The subjectively perceived physical work ability was rated on a scale from 1-5, where 1 equals poor and 5 describes excellent work ability (Appendix 1, question 17).

Both height and weight were measured and based on the values the Body Mass Index (BMI) was calculated. The formula for calculation of BMI is weight · height^2 (Keskinen et al. 2010, 46).

The UKK-Institute's 2 km walk test is a field test that was created in the beginning of the 1990's by the UKK-Institute with the aim to be able to measure the condition in population studies and hence in larger groups (UKK-Institute, 2016). The test has been developed, and research about the reliability of the test has been systematically done already since 1986 (Keskinen et al. 2010, 104). The walk test was created specially to measure the condition of adults in ages 20-65 years who exercise only a little or are completely passive. The test was made also for the purpose to work as a tool for promotion of health and daily exercise among citizens. For athletes and individuals with good condition this test is not recommended since it's an indirect test and gives approximate values instead of absolute. Other factors that might affect the results are medication, severe overweight and the environment where the test is performed. The walk test is performed on a flat surface (like a sports field) where the people being tested are instructed to walk 2 km as fast as possible. (Oja et al. 2000, 32–36.)

In this study the 2 km walk test was used to measure the maximal oxygen consumption (VO_2max) before and after the intervention. The values were also measured four years after the intervention. The individual VO_2max-value was estimated with a verified algorithm

which is based on the persons age, sex, weight & height (BMI), time used for walking and heart rate at the finish line. A heart rate monitor (Polar Electro, M61, Finland) was used during the test for measuring the intensity of the exercise. The algorithm for estimation of the maximal oxygen consumption for women performing the UKK-walk test is:
VO_2max (ml/kg/min) = 116,2 –2,98 x (time; min) –0,11 x (heart rate) –0,14 x (age) – 0,39 x (BMI) (Keskinen et al. 2010, 104).

4.2.2 Data analysis

Statistical analysis was performed with the SPSS software (IBM SPSS Statistics). For variables on baseline was used average, percentage values, standard deviation, Mann-Whitney U-test, Independent Samples T-test, Fisher's exact test and Chi-squared test.

Statistical analysis was provided by the UKK-Institute and transcribed by the thesis author in close collaboration with the statistician.

4.3 Research ethics

This thesis uses good academic practices throughout the whole study. The purpose of this thesis is to study the phenomenon of a larger group of people and therefore not to look at results on individual level. All participants in the survey have participated voluntarily and will remain anonymous. All results are analyzed in its original entirety without modification.

The original MELLI-study has received the approval of the *Pirkanmaa Hospital District Ethics Committee* and all participants have signed a written consent.

5 RESULTS

In this chapter are all the results presented and illustrated with tables. Sub headings divide the results according to the research questions.

5.1 Intervention and control group at baseline

This thesis focused on including the 62 women that worked full- or part-time and had values on BMI, VO_2max and perceived physical work ability at the four-year follow-up. Few missing values did occur in VO_2max and work ability scores at baseline and immediately after the intervention. The missing values are marked in each table separately. Hence, the number of women (n) will slightly vary depending on which variables are analysed.

At baseline there were no statistically significant differences between the intervention group (IG) and control group (CG) (Table 3). The average age of the women was 54 years in both groups with a standard deviation (SD) of approximately three years.

TABLE 3. Intervention and control group at baseline

	Intervention group (IG)	**Control group** (CG)	**n** IG+CG	**p-value**
Age (years)	54.7 (SD 2.9)	54.1 (SD 3.5)	34+28	0.86 [1]
Education				0.67 [2]
elementary school	10 (29.4%)	10 (35.7%)	34+28	
high school/vocational school	16 (47.1%)	10 (35.7%)		
university/vocational university	8 (23.5%)	8 (28.6%)		
Type of work			31+26	0.92 [2]
physical	6 (19.4%)	4 (15.4%)		
psychological	19 (61.3%)	17 (65.4%)		
physical and psychological	6 (19.4%)	5 (19.2%)		
BMI (kg/m^2)	25.5 (SD 3.5)	27.0 (SD 4.8)	34+28	0.19 [1]
VO_2Max (ml/kg/min)	33.2 (SD 4.5)	32.3 (SD 4.4)	33+28	0.50 [1]
Perceived work ability in terms of the physical demands of work (1=poor…5=excellent)	3.78 (SD 0.75)	3.82 (SD 0.67)	32+28	0.88 [1]

[1] *Independent Samples T-test*
[2] *Chi-squared test*
[3] *Mann-Whitney U-test*

Most of the women (61.3% in the intervention group and 65.4% in the control group) worked with psychologically demanding tasks (like office work). Even physical jobs (like cleaning) as well as physically and psychologically demanding jobs (like nurses) were represented. 23.5% of the intervention group and 28.6% of the control group had higher education (University or University of Applied Sciences).

On a scale from 1 to 5 (1=poor…5=excellent), the physical work ability was perceived to be 3.78 (SD 0.75) and 3.82 (SD 0.67) in intervention and control group respectively.

The mean BMI-values (kg/m^2) were 25.5 ± 3.5 (intervention) and 27.0 ± 4.8 (control).

The average maximal oxygen consumption (VO_2max) was 33.2 ± 4.5 ml/kg/min (intervention) and 32.3 ± 4.4 ml/kg/min (control).

5.2 Effect of the intervention on maximal oxygen consumption and BMI

The maximal oxygen consumption increased 0.7 ml/kg/min after six months of exercise in the intervention group and remained almost the same in the control group. The changes in between the groups where almost statistically significant (p=0.057). The VO_2max decreased relatively more in the intervention group and were in both groups on nearly the same level at the four-year follow-up. The decrease between the groups where statistically significant (p=0.031).

TABLE 4. Changes in the average maximal oxygen consumption (VO_2max, ml/kg/min)

	Intervention group (IG)	**Control group** (CG)	**n** IG + CG	**p-value**
VO_2max at baseline	**33.2 (SD 4.5)**	**32.3 (SD 4.4)**	33+28*	
VO_2max at 6 months	**33.9 (SD 4.4)**	**32.2 (SD 4.6)**	33+28*	
Change in VO_2max (6 months – baseline)	0.7 (SD 2.3) (+2.4%)	-0.1 (SD 1.4) (-0.2%)		0.057 [1]
VO_2max at 4-year follow-up	**31.5 (SD 4.9)**	**31.6 (SD 5.1)**	34+28	
Change in VO_2max (4 years – baseline)	-1.7 (SD 4.5) (-4.9%)	-0.7 (SD 2.5) (-1.9%)		0.031 [1]

[1)] Mann-Whitney U-test
[*)] Missing values: 1+0, 1+0

The intervention group was divided into a three-level categorization according to the VO_2max-value at baseline with the purpose to study more detailed the differences between the women (Table 5). The three-level categorization is chosen based on the average VO_2max-value and its low standard deviation. At this point the study design is changing from the original setting, the randomized controlled trial (RCT), because the participants are divided consciously into smaller groups according to their test values. During the six months long trial there was an improvement of the VO_2max-value in all the condition groups. The most significant change could be seen in the two lowest condition classes where the majority (71.4% and 61.5%) improved their condition. The same trend can be seen four years after the baseline, when still 42.9% of the ones in the lowest condition class improved their VO_2max-value. In the middle and highest condition class is the comparable result only 7.7%. The results are, however, statistically not significant.

TABLE 5. Changes in VO_2max among intervention group according to a three-level categorization

VO_2max improved	**baseline – 6 months**[1] n=33[*]		**baseline - 4 years**[2] n=33[*]	
	No	**Yes**	**No**	**Yes**
VO_2max at baseline				
Under 29	2 (28.6%)	5 (71.4%)	4 (57.1%)	3 (42.9%)
29-34	5 (38.5%)	8 (61.5%)	12 (92.3%)	1 (7.7%)
Over 34	7 (53.8%)	6 (46.2%)	12 (92.3%)	1 (7.7%)

P-value [1)] 0.67 (Fisher's exact test), 0.16 (Kruskal-Wallis test)
[2)] 0.11 (Fisher's exact test), 0.099 (Kruskal-Wallis test)
[*)] Missing values: 1+1

Both the intervention and the control group diminished slightly their BMI after the intervention (Table 6). At the four-year follow-up the results showed that the intervention group had a change of 0.99 in the average BMI and the equivalent result for the control group is 0.08. This result is statistically significant (p=0.009, Mann-Whitney U-test).

TABLE 6. Changes in BMI-values

	Intervention group (IG)	**Control group** (CG)	**n** IG+CG	**p-value**
BMI at baseline	**25.5 (SD 3.5)**	**27.0 (SD 4.8)**	34+28	
BMI at 6 months	**25.2 (SD 3.5)**	**26.6 (SD 4.8)**	34+28	
Change in BMI (6 months – baseline)	-0.36 (SD 1.8)	-0.40 (SD 0.50)		0.30 [1]
BMI at 4-year follow-up	**26.5 (SD 3.4)**	**27.1 (SD 5.0)**	34+28	
Change in BMI (4 years – baseline)	0.99 (SD 2.8)	0.08 (SD 1.6)		0.009 [1]

[1] Mann-Whitney U-test

5.3 Effect of intervention on perceived physical work ability

The intervention's influence on the perceived physical work ability can be seen when comparing the intervention and control group (Table 7). The average (3.78) at baseline improved in six months on a scale from 1 to 5 among (1=poor…5=excellent) in the intervention group with 0.35 units. Among the control group the average (3.93) increased with 0.11 units. In the four-year follow-up both groups diminished their results; the intervention group with 1.69 units and the control group with 1.57 units. On long-term was the diminishing of the intervention group's values relatively bigger than the control group's. The finding does not reach the level of significance.

TABLE 7. Changes in perceived physical work ability

	Intervention group (IG)	**Control group** (CG)	**n** IG+CG	**p-value**
Work ability at baseline	**3.78 (SD 0.75)**	**3.82 (SD 0.67)**	32+28*	
Work ability at 6 months	**4.13 (SD 0.75)**	**3.93 (SD 0.68)**	32+27*	
Change in work ability (6 months–baseline)	0.35 (+9.3%)	0.11 (+2.9%)		0.28[1]
Work ability at 4-year follow-up	**2.09 (SD 0.97)**	**2.25 (SD 0.84)**	34+28	
Change in work ability (4 years–baseline)	-1.69 (-44.7%)	-1.57 (-41.1%)		0.42[2]

1) Independent Samples T-test
2) Mann-Whitney U-test
**) Missing values: 2+ 0, 2+1*

The majority (90%) of the intervention group manage to improve or maintain their perceived work ability during the intervention (Table 8). The equivalent number of the control group is 77.8%. Four years after the intervention the results diminished, that is, the majority reported that their perceived work ability got worse; 68.8% among intervention group and 85.7% among control group. The result does not reach the level of significance.

TABLE 8. Changes in perceived work ability in terms of the physical demands of work

	Intervention group (IG)	Control group (CG)	n IG+CG	p-value
6 months – baseline			30+27*	0.33[1]
Got worse	3 (10.0%)	6 (22.2%)		
Stayed the same	15 (50.0%)	14 (51.9%)		
Got better	12 (40.0%)	7 (25.9%)		
4 years – baseline			32+28*	0.19[2]
Got worse	22 (68.8%)	24 (85.7%)		
Stayed the same	9 (28.1%)	3 (10.7%)		
Got better	1 (3.1%)	1 (3.6%)		

1) Chi-squared test
2) Fisher's exact test
**) Missing values: 4+1, 2+0*

When studying the differences within the intervention group in the same three-level categorization utilized as in chapter 5.2 (based on the condition level at baseline) it can be seen that the majority in all three condition levels improved the state of perceived work ability after the six-month trial (Table 9).

TABLE 9. Changes in the perceived physical work ability among the intervention group

Work ability improved or stayed the same	**Baseline to 6 months[1]** n=29*		**Baseline to 4 years[2]** n=31*	
	No	**Yes**	**No**	**Yes**
VO_2max at baseline				
Under 29	0	6 (100%)	3 (50.0%)	3 (50.0%)
29-34	1 (9.1%)	10 (90.9%)	8 (61.5%)	5 (38.5%)
Over 34	2 (16.7%)	10 (83.3%)	11 (91.7%)	1 (8.3%)

P-value 1) 0.78 (Fisher's exact test)
2) 0.13 (Fisher's exact test)
**) Missing values: 5+3*

The results show that four years after the intervention was the improvement still the highest among the two lowest condition levels. 50% of the women with VO_2max under 29 ml/kg/min at baseline improved or maintained their perceived work ability still four years after the intervention. The level of significance for the difference between the groups concerning the improved work ability is not reached either six months (p=0.78) or four years (p=0.13) after baseline (Fisher's exact test).

6 DISCUSSION

The aim of this study was to investigate the short-term (6 months) and long-term (4 years) impact of a six months long physical exercise intervention on physical capacity (VO_2max) and on the perceived physical work ability among middle aged women.

6.1 The impact of the intervention on physical capacity

The maximal oxygen consumption results, used as the determinants of physical capacity, signify that the women were in general in good physical condition in the beginning of the intervention comparing to women in the same age (Chapter 3.1, Table 1).

The intervention group managed to slightly improve their VO_2max-value meanwhile the control group decreased their average during the trial. Even if the results do not quite reach the level of significance, this indicates that regular exercise during the intervention had a positive short-term effect on the maximal oxygen consumption of the intervention group. In the previously published part of this study (Nygård 2014), where the sample was notably bigger (n=105), the outcome of regular physical exercise during the intervention reached the level of significance (p=0.003). Similar positive results of a physical exercise intervention have been found in another Finnish study (Asikainen et al. 2002) that studied in a 24-week-long randomized controlled trial the minimal amount of physical exercise needed to improve fitness among postmenopausal women (n=121). Hence it can be pondered, that the size of the sample in this study might have affected the result.

In the four-year follow-up the result was not as cheerful. Both groups diminished their VO_2max-values from the baseline value. This means that the intervention only had a positive short-term effect but no long-term effect on the intervention group. However, factors that might affect the result are biological factors like yearly diminishing of VO_2max by 0.1% (Keskinen et al. 2010, 53) and changes in body weight.

The average BMI-value indicated at baseline on a slight overweight (Keskinen et al. 2010, 45) among both groups. Physical activity has proved to lower the BMI-value (Fogelholm et al. 2006), but in this study, there was not any major changes immediately after the intervention. However, at the four-year follow-up an interesting change could be seen. In opposite to the assumption, the BMI-value within the intervention group rose more radically than among the control group. An explanation to this might be the size of the sample which allows major individual changes to affect the whole group. In this study, even small changes in the BMI-value might affect the calculations of the maximal oxygen consumption since the mathematical formula (ml/kg/min) takes into consideration the weight of the person. In other words, a physically passive person might have increased her VO_2max-value with a weight loss instead of improving her cardiorespiratory fitness at all. Thus, this speculation would require deeper research on the individual results before being confirmed.

In depth studies of the results of the intervention group shows that the VO_2max-value improved during the intervention the most among women who were in the first and second category of the three-level classification of VO_2max presented in Chapter 5.2. This means, that the women with slightly lower VO_2max-values at baseline benefited most of the intervention. A reason to this might be that the ones that already were in excellent condition had harder to improve their values (Keskinen et al. 2010, 76) and some women might have already reached their personal maximal level. The phenomena can be described by a diagram created by Russel Paten in 1995 (Figure 7), where it is emphasized that the benefits of a certain amount of physical exercise are higher among the previously sedentary individuals in comparison to the previously active ones (Figure 7) (Fogelholm et al. 2011, 70).

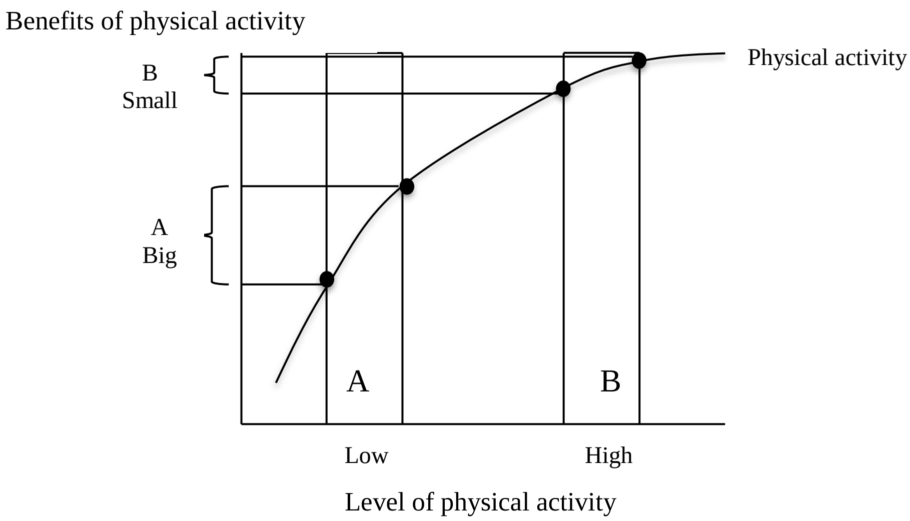

FIGURE 7. Benefits of physical activity in relation to level of activity (Fogelholm et al. 2011).

In the diagram is the relationship between physical activity and its benefits described. It can be seen that the same amount of physical activity impact in different ways according to the individual's original activity level. The ones that have a low activity level (A) are rewarded with a big amount of benefits (A) when they start exercising. Since the ones with high level of physical activity (B) already have gained the primary benefits of exercising is the amount of gained benefits relatively low with frequent exercise. (Fogelholm et al. 2011, 70.)

In the results, none of the groups in the three-level classification improved their VO_2max significantly on a long-term from baseline. However, it needs to be underlined that almost half of the women in the first category (VO_2max under 29 ml/kg/min) had four-years after the intervention a higher VO_2max-value than at baseline. The equivalent values for the higher VO_2max -categories was about ten percentage, which indicates that the intervention yet might have had a positive long-term effect on the women who were classified in the lowest VO_2max-category at baseline and this finding support the above-mentioned theory by Russel Paten.

Due to its characteristics, there is a chance that the execution of the UKK-Institute's 2 km walk test might have slightly varied from the previous execution and therefore might de results been affected on some level. But nonetheless, it is very possible that the lack of regular exercise led to the diminishing values in case the women returned to a sedentary lifestyle after the termination of the intervention. In conclusion, the intervention did not have a long-term effect on the maximal oxygen consumption.

6.2 The impact of the intervention on the perceived physical work ability

The study indicated on a minor, statistically not significant, improvement of perceived physical work ability in both the intervention and control group after the six months long trial. After six months the majority reported that their work ability stayed the same or got better during the intervention. The number of women who reported that their work ability got worse during the trial was twice as big in the control group in comparison to the intervention group, which might show the positive effect of the trial on the women who were following the instructions of regular physical exercise on leisure-time. Even if the results are not statistically significant, the findings point to the right direction that physical activity would impact positively on perceived physical work ability.

At the four-year follow-up the intervention group managed to maintain their perceived physical work ability relatively better than the control group. In the intervention group almost a third reported that their work ability stayed the same, meanwhile the equivalent number in the control group was only a tenth. The result is statistically not significant, but it shows that there is a chance for a positive long-term correlation between a physical exercise trial and the ability to improve or maintain work ability. Reasons why the p-value was not small enough to reach the level of significance could be for example the size of the sample, method of measurement, work tasks, work time and the length of the intervention. Another research (Smolander et al. 2000) compared two exercise programs for six months in a controlled trial with the aim to study their effect on the work ability among healthy adults. The study resulted in a significant improvement in the maximal oxygen consumption, but the work ability remained unchanged. The minor positive correlation between physical activity and improvement in work ability can be partly explained with the effect physical exercise have on the interaction between physical, psychological and social components, which together battle against work-related strain (Vuori 2010; Penedo et al. 2005).

The intervention group decreased their perceived physical work ability average during the four years by half. Same trend could be seen within the control group. In a small sample big changes are possible. The results at the four-year follow-up can be interpreted so that the women in both groups experienced their physical work ability to be low. In a study (Gould et al. 2008) only 17% of women aged 60-64 years experienced their physical work ability to be very good, meanwhile from a younger group (55-59 years) in the same sample the equivalent result was 29%. The study concluded that the work ability of the oldest group was exceptionally poor, and a clear decrease can be seen with the age.

A finding that supports the diagram by Russel Paten presented in Chapter 6.1 (Figure 7) is found when analysing the VO_2max-values and work ability scores in this study. At both points of measurement (six months and four years), it could be seen that the perceived physical work ability stayed the same or improved more commonly among the women with a lower VO_2max-value at baseline. This might indicate that the impact of physical exercise on work ability is, likewise to effects of physical exercise, bigger on those women in lower condition classes. However, that statement cannot be confirmed with the current sample size and data.

6.3 Reflections

After six months of physical exercise the intervention group increased the maximal oxygen consumption more than the control group and the changes between the groups where almost statistically significant ($p=0.057$). After four years the VO_2max had decreased and were on about the same level in both groups. There were no statistically significant changes in the perceived physical work ability between the groups after neither six months nor four years.

A clear difference can be seen in the proportions of the individuals that practices physical exercise on leisure time in Finland depending on the level of their education. Among women with an education that lasted for more than 13 years practice in average 80% physical exercise on their leisure time. Among women educated for less than 10 years the equivalent number is 66%. (Helldán et al. 2015, 143.) In this thesis, a fourth of the women had continued to study after high school, that is had studied for over 13 years. A third of the sample did not continue to high school/vocational school. The likelihood that the results in this thesis are affected of the level of education is small, but it needs to be taken into consideration.

A study (Lehto et al. 2013) indicated that the socioeconomic status has an impact on the total amount of the practiced physical activity; individuals with a higher socioeconomic status practiced more physical activity on leisure time meanwhile individuals in a lower status were more active during work. Similar conclusion was made in the most recent (2016) *Working life Barometer* that stated that there is a clear connection between the socioeconomic status and perceived work-related physical strain. The ones with a higher position experience less physical but more psychological stress than the ones in a lower position and vice versa. (Mähönen 2017, 89-94.)

Good work ability is a part of an organizations Corporate Social Responsibility (CSR), meaning that it is also in general strategically important to the organization (Rauramo 2008, 18-19). It has been shown that a healthy workforce results in job-satisfaction, independency and growth of productivity and quality of results in an organization (Tuomi et al. 2001; Ilmarinen 2001; Matikainen et al. 1995, 25-30). Productivity results in benefits for the individual, the workplace and thereby for the society (Rauramo 2008, 18-20). Depending on the job characteristics and the surrounding environment, all people have different opportunities to take care of their health. For example, shift workers might not be able to adjust their schedules as well as office workers in a way that allows participation in regular health improving hobbies. Instead of having the employee struggling with finding a way to build a balanced week could the employer support the possibility of leisure time activities with for example fixing the shift patterns to more flexible and regular. As described in the *Work Ability House* in Chapter 3.2, the responsibility of work ability is divided on multiple components and actors, not only on the individual (Ilmarinen 2006, 79-81). Equality within maintenance and improvement of work ability despite the educational background and socioeconomic status would require actions towards more determined structural and cultural changes in workplaces and the society.

In Finland has work ability maintaining programs (TYKY) been implemented already in the beginning of 1990's. Successful programs rely on active collaboration between the employee and the workplace, but also with external parties like occupational health providers, pension providers and policy makers. (Rauramo 2008, 24-27.) Pekka & Pekkarinen (2015) analysed the situation of strategic work ability promoting leadership models in the municipal sector and found out that even though maintenance of work ability is seen as an organizational goal, is there still challenges in its practical execution. Even if about half of the leaders in municipal organizations consider that they have done actions towards prolonging of carriers, yet there are not usually concrete measurable goals written in the organization's policy. One reason is lack of enough education and knowledge on different health promoting models and early support that leaders are expected to implement. (Pekka & Pekkarinen 2015, 4-34.) It has been suggested that inactivity should be reacted to and fought against more actively on a societal level, especially since the yearly expenses are significant and growing (Vasankari et al. 2018).

6.4 Strengths, limitations and suggestions for future studies

A definitive strength of this study is the wide scope of measuring methods, collected data and the multi-professional research group from the original MELLI-study by the UKK-Institute. The Finnish material eases the opportunity for generalization within a correlative target group in the rest of the population, especially the results that were statistically significant. The original study design was validated by the Pirkanmaa hospital district’s ethical committee and supervised by a monitoring group, and therefore can the study be seen ethically correct completed and the results are considered trustworthy. However, the data measured at baseline was measured nearly ten years ago (2009) and hence it can be pondered if working tasks are using more automatization and technology nowadays. This development might shift the work-related requirements from physically towards more psychologically demanding.

In both the original study and this thesis, no significant differences could be seen between the intervention and control group when comparing the variables at baseline. This is a sign of a successful randomization of the sample and thereby is the study design correctly executed and the results are comparable (Jacobsen 2007, 79-81). A randomized controlled trial is an ideal way to experiment even if some criteria need to be fulfilled and therefore it can be hard to execute (Jacobsen, 2007, 79-84). There have not been done many RCTs within the topic and target group in question (Luoto et al. 2012). A factor that can be seen as a weakness in this study is that from the original sample (176 women) only 62 were chosen for the analysis of the effect of the exercise intervention on the perceived physical work ability. The reason to this is well-motivated since there was not available all relevant data for all participants four years after the intervention in the follow-up. However, this also means that when the sample became smaller was also the chance for getting statistically significant results diminished.

The UKK-Institute's 2 km walk test is applicable for both practical and scientific purposes (Luoto et al. 2012). Despite this, it is still an indirect test that gives an estimation of the VO_2max-value. Factors like weight and fitness level can affect the results (Keskinen et al. 2010, 107). To get exact VO_2max-values should have been done a direct test, but this would have required a lot more time and money.

To get more comprehensive answers about the perceived physical work ability could have instead of a five-classed classification been used a broader scale, for example the RPE-scale which is a 15-step classification (Keskinen et al. 2010, 39). The RPE-scale has been used before within Finnish studies about work-related strain (Nygård et al. 1988) and the intervention group in the UKK-Institute's MELLI-study used the scale to describe the intensity of their exercise (Luoto et al. 2012). Another much used tool is the Work Ability Index (WAI) that was created in Finland in the 1980s. The WAI is a questionnaire that includes seven items that are scored based on one or more questions. (Ilmarinen 2009.) The first item, the Work Ability Score (WAS) (Jääskeläinen et al. 2016), could have been a possible source of data to this study (Appendix I, question 16). This question would have provided a broader answering scale for the participants but would meantime have focused on the holistic view of work ability instead of the physical aspect. By using a broader scale could most likely more significant individual changes and differences between individuals have been seen.

Workplace interventions have shown to have debatable impacts on work ability. Some interventions have resulted in minor improvements (Oakman et al. 2018), yet more research is required for any conclusion. This intervention focused on a certain period of time, in a certain point of a lifespan, hence it is questionable if that gives long-term information on how the women are or have been taking care their health and wellbeing. Taking care of one's health should be a holistic and lifelong intervention with constant follow-ups and adjustments according to one's life situation.

It would have been ideal to see some positive results in the four-year follow-up. Despite the unexpected outcome, it has been fruitful to learn and speculate different reasons that might have affected the results. If a further study would be done, it would be recommended to have a bigger sample and more specific data collecting methods and questions. It would be interesting to understand better the societal effects of physical activity and how work-related health habits could be improved in a larger scope. Even if this study hypothetically could represent close to 0.5 million Finnish women in menopause (see Chapter 2), the results of the target group in this study cannot be generalized. Especially when the results in this study were not statistically significant.

6.5 Conclusions

Progressive leisure-time physical exercise for six months did have a positive, although statistically not significant, short-term effect on VO_2max and perceived physical work ability among middle aged women. This study does not indicate that there would have been a positive long-term effect of the intervention on the variables. Both groups diminished their perceived physical work ability and VO_2max values at the four-year follow-up.

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APPENDIX I

MELLI-tutkimus

SEURANTAKYSELY 2013

Kyselyn täyttöpäivä _____/_____/_________

Lääkkeiden käyttö

1. Oletteko viimeksi kuluneiden 6 kk aikana käyttänyt kertaakaan mitään lääkärin määräämää reseptilääkettä (alle 45-vuotiailla naisilla ehkäisytabletit mukaan luettuna)

1 kyllä 2 ei

2. Onko käytössänne tällä hetkellä mitään lääkärin määräämää reseptilääkettä?

1 kyllä 2 ei

3. Minkä nimiset lääkkeet teillä on käytössänne? Myös satunnaisesti otettavat lääkkeet.

____

____

4. Oletteko viimeksi kuluneen viikon (7 pv) aikana käyttänyt mitään tabletteja, pulvereita tai muita lääkkeitä?

	Kyllä
verenpainelääkkeitä	1
päänsärkylääkkeitä	1
muita särkylääkkeitä	1
ehkäisypillereitä	1
rauhoittavia lääkkeitä	1
unilääkkeitä	1
masennuslääkkeitä	1
vitamiini- ja kivennäisvalmisteita	1
yskänlääkettä	1
kolesterolilääkkeitä	1
hormonilääkkeitä vaihdevuosiin (tai niiden jälkeiseen aikaan) naisille	1

Elämänlaatu

5. **Onko terveytenne yleisesti ottaen** (valitkaa yksi numero)

1 erinomainen
2 varsin hyvä
3 hyvä
4 tyydyttävä
5 huono

6. Jos vertaatte nykyistä terveydentilaanne vuoden takaiseen, onko terveytenne yleisesti ottaen (valitkaa yksi numero)

1 tällä hetkellä paljon parempi kuin vuosi sitten
2 tällä hetkellä jonkin verran parempi kuin vuosi sitten
3 suunnilleen samanlainen
4 tällä hetkellä jonkin verran huonompi kuin vuosi sitten
5 tällä hetkellä paljon huonompi kuin vuosi sitten

7. Seuraavassa luetellaan erilaisia päivittäisiä toimintoja. Rajoittaako terveydentilanne nykyisin suoriutumistanne seuraavista päivittäisistä toiminnoista? Jos rajoittaa, kuinka paljon? (valitkaa yksi numero joka riviltä)

		kyllä, rajoittaa paljon	kyllä, rajoittaa hiukan	ei rajoita lainkaan
a.	huomattavia ponnistuksia vaativat toiminnat (esimerkiksi juokseminen, raskaiden tavaroiden nostelu, rasittava urheilu)	1	2	3
b.	kohtuullisia ponnistuksia vaativat toiminnat, kuten pöydän siirtäminen, imurointi, keilailu	1	2	3
c.	ruokakassien nostaminen tai kantaminen	1	2	3
d.	nouseminen portaita useita kerroksia	1	2	3
e.	nouseminen portaita yhden kerroksen	1	2	3
f.	vartalon taivuttaminen, polvistuminen, kumartuminen	1	2	3
g.	noin kahden kilometrin matkan kävely	1	2	3
h.	noin puolen kilometrin matkan kävely	1	2	3
i.	noin 100 metrin matkan kävely	1	2	3
j.	kylpeminen tai pukeutuminen	1	2	3

8. Onko teillä viimeisen 4 viikon aikana ollut ruumiillisen terveydentilanne takia alla mainittuja ongelmia työssänne tai muissa tavanomaisissa päivittäisissä tehtävissänne? (valitkaa yksi numero joka riviltä)

		kyllä	ei
a.	Vähensitte työhön tai muihin tehtäviin käyttämäänne aikaa	1	2
b.	Saitte aikaiseksi vähemmän kuin halusitte	1	2
c.	Terveydentilanne asetti teille rajoituksia joissakin työ- tai muissa tehtävissä	1	2
d.	Töistänne tai tehtävistänne suoriutuminen tuotti vaikeuksia (olette joutunut esim. ponnistelemaan tavallista enemmän)	1	2

9. Onko teillä viimeisen 4 viikon aikana ollut tunne-elämään liittyvien vaikeuksien (esim. masentuneisuus tai ahdistuneisuus) takia alla mainittuja ongelmia työssänne tai muissa tavanomaisissa päivittäisissä tehtävissänne?
(valitkaa yksi numero joka riviltä)

		Kyllä	ei
a.	Vähensitte työhön tai muihin tehtäviin käyttämäänne aikaa	1	2
b.	Saitte aikaiseksi vähemmän kuin halusitte	1	2
c.	Ette suorittanut töitänne tai muita tehtäviänne yhtä huolellisesti kuin tavallisesti...........................	1	2

10. Missä määrin ruumiillinen terveydentilanne tai tunne-elämän vaikeudet ovat viimeisen 4 viikon aikana häirinneet tavanomaista (sosiaalista) toimintaanne perheen, ystävien, naapureiden tai muiden ihmisten parissa? (valitkaa yksi numero)

1 ei lainkaan
2 hieman
3 kohtalaisesti
4 melko paljon
5 erittäin paljon

11. Kuinka voimakkaita ruumiillisia kipuja teillä on ollut viimeisen 4 viikon aikana? (valitkaa yksi numero)

1 ei lainkaan
2 hyvin lieviä
3 lieviä
4 kohtalaisia
5 voimakkaita
6 erittäin voimakkaita

12. Kuinka paljon kipu on häirinnyt tavanomaista työtänne (kotona tai kodin ulkopuolella) viimeisen 4 viikon aikana? (valitkaa yksi numero)

1 ei lainkaan
2 hieman
3 kohtalaisesti
4 melko paljon
5 erittäin paljon

Seuraavat kysymykset koskevat sitä, miltä teistä on tuntunut viimeisen 4 viikon aikana. Merkitkää kunkin kysymyksen kohdalla se numero, joka parhaiten kuvaa tuntemuksianne.

13. Kuinka suuren osan ajasta olette viimeisen 4 viikon aikana ...
(valitkaa yksi numero joka riviltä)

	koko ajan	suurim- man osan aikaa	huomat- tavan osan aikaa	jonkin aikaa	vähän aikaa	en lainkaan
a. tuntenut olevanne täynnä elinvoimaa	1	2	3	4	5	6
b. ollut hyvin hermostunut	1	2	3	4	5	6
c. tuntenut mielialanne niin matalaksi, ettei mikään ole voinut teitä piristää	1	2	3	4	5	6
d. tuntenut itsenne tyyneksi ja rauhalliseksi	1	2	3	4	5	6
e. ollut täynnä tarmoa	1	2	3	4	5	6
f. tuntenut itsenne alakuloiseksi ja apeaksi	1	2	3	4	5	6
g. tuntenut itsenne "loppuunkuluneeksi"	1	2	3	4	5	6
h. ollut onnellinen	1	2	3	4	5	6

i. tuntenut itsenne väsyneeksi ....1 .... 2...........3 .... 4............5 6

14. <u>Kuinka suuren osan ajasta</u> ruumiillinen terveydentilanne tai tunne-elämän vaikeudet ovat viimeisen 4 viikon aikana häirinneet tavanomaista sosiaalista toimintaanne (ystävien, sukulaisten, muiden ihmisten tapaaminen)?
(valitkaa yksi numero)

1 koko ajan
2 suurimman osan aikaa
3 jonkin aikaa
4 vähän aikaa
5 ei lainkaan

15. Kuinka hyvin seuraavat väittämät pitävät paikkansa teidän kohdallanne?
(valitkaa yksi numero joka riviltä)

	pitää ehdottomasti paikkansa	pitää enimmäkseen paikkansa	en osaa sanoa	enimmäkseen ei pidä paikkansa	ehdottomasti ei pidä paikkansa
a. Minusta tuntuu, että sairastun jonkin verran helpommin kuin muut ihmiset	1	2	3	4	5
b. Olen vähintään yhtä terve kuin kaikki muutkin tuntemani ihmiset	1	2	3	4	5
c. Uskon, että terveyteni tulee heikkenemään	1	2	3	4	5
d. Terveyteni on erinomainen	1	2	3	4	5

Työkyky nyt verrattuna elinaikaiseen parhaimpaan

16. Oletetaan, että työkykynne on parhaimmillaan saanut 10 pistettä. Minkä pistemäärän antaisitte nykyiselle työkyvyllenne?
(0 tarkoittaa sitä, ettette nykyisin pysty lainkaan työhön)

0 1 2 3 4 5 6 7 8 9 10

Työkyky työn vaatimusten kannalta

17. Millaiseksi arvioitte nykyisen työkykynne työnne, *ruumiillisten* vaatimusten kannalta?

Erittäin hyvä	5
Melko hyvä	4
Kohtalainen	3
Melko huono	2
Erittäin huono	1

***henkisten* vaatimusten kannalta?**

Erittäin hyvä	5
Melko hyvä	4
Kohtalainen	3
Melko huono	2
Erittäin huono	1

18. Kuinka fyysisesti ja henkisesti rasittavaksi arvioitte menneen päivän?

fyysisesti

hyvin kevyt	1
kevyt	2
hieman rasittava	3
rasittava	4
hyvin rasittava	5

henkisesti

hyvin kevyt	1
kevyt	2
hieman rasittava	3
rasittava	4
hyvin rasittava	5

19. Mikä on nykyinen työtilanteenne? Oletteko…

1 kokopäivätyössä?
2 osa-aikatyössä?
3 opiskelija?
4 eläkkeellä, kuinka kauan olette ollut? __ vuotta __ kuukautta
5 työtyön tai lomautettu, yhtäjaksoisesti? __ vuotta __ kuukautta
6 hoitamassa omaa kotitaloutta tai perheenjäseniä?
7 äitiyslomalla tai hoitovapaalla?
8 sairauslomalla, yhtäjaksoisesti? __ vuotta __ kuukautta
9 muu, mikä? ________________________________

20. Mikä on ammattinne tai viimeisin ammattinne, jos ette nyt ole työelämässä?

____

____

Kuvailkaa muutamalla sanalla työtehtäviänne

____

____

____

21. Miten nykyinen painonne eroaa painostanne 3,5 v. sitten?

1 lisääntynyt ____ kg
2 pysynyt ennallaan ____ kg
3 vähentynyt n. ____ kg

22. Miten paljon painatte kevyissä vaatteissa punnittuna?

____ kg