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PHYSICAL ACTIVITY FOR HEALTH AFTER MENOPAUSE

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SUMMARY

There is strong evidence that physical activity and exercise are beneficial for health promotion and disease prevention in women after menopause. This text examines the effects of regular physical exercise on climacteric symptoms, body composition and public health diseases, such as cardiovascular disease, type 2 diabetes mellitus, osteoporosis, breast cancer and depression in postmenopausal women.

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TAKE HOME MESSAGES:

- Regular physical activity counteracts climacteric symptoms, weight gain and increased abdominal fat related to menopause.
- Endurance and resistance exercise improves cardiovascular risk factors, such as blood pressure, serum lipids and endothelial function in a dose-dependent manner.
- Vigorous exercise on a regular basis reduces the risk of cardiovascular disease, stroke and overall mortality approximately by 30% in postmenopausal women.
- Regular aerobic training improves insulin sensitivity and glucose tolerance and prevents type 2 diabetes in women after menopause.
- There is evidence of a dose-dependent positive effect of exercise on bone mass in postmenopausal women.
- Resistance training improves muscular strength and functional abilities in elderly individuals.
- Regular physical activity is associated with a 25% risk reduction of breast cancer and improved breast cancer survival.
- Aerobic training in a dose-dependent manner improves depressive symptoms in women with menopausal symptoms.
- Regular physical exercise including aerobic, resistance, neuromotor and flexibility training is recommended for all healthy women after menopause to improve and maintain physical and mental health.

MENOPAUSE AND CLINICAL SYMPTOMS

During the menopausal transition, cyclic secretion of female sex hormones, i.e. oestradiol and progesterone from the ovaries disappears and the production of these hormones declines gradually. This transition may last from a couple of months to 10 to 15 years. In contrast, circulating levels of male hormones, e.g. testosterone, decline as a consequence of age-related reductions in secretion by both the adrenal glands and the ovaries. Menopause, the final cessation of menstruation, occurs when functioning ovarian follicles become depleted and the production of oestradiol is too low to stimulate the endometrium to grow and then shed. As a consequence of low oestradiol production, circulating levels of follicle stimulating hormone (FSH) from the pituitary will increase (Figure 1). Menopause is established by a marked elevation of FSH in the blood. The median age of menopause is 52 years in the Western world.

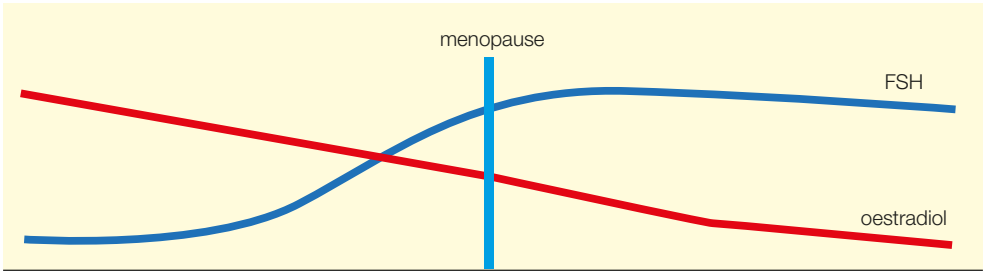

Figure 1. Circulating levels of oestradiol and FSH during menopausal transition.

Early symptoms of declining female sex hormones are changed bleeding patterns. The first sign is usually shortening of the menstrual cycle, i.e. reduced number of days from the onset of one menstrual period until the next menstrual period. This is often caused by luteal phase defects associated with subnormal oestradiol levels in the follicular phase of the menstrual cycle, leading to reduced follicular development, delayed ovulation and reduced progesterone secretion by the corpus luteum of the ovary during the luteal phase. Next stage is when menstrual cycles become anovulatory, i.e. follicular maturation is inadequate to initiate ovulation. This pattern is characterized by irregular and heavy bleedings. Thereafter, the normal progression is lighter flow and longer intervals before complete termination of menses.

A majority of women around menopause report vasomotor symptoms with hot flushes and sweats, particularly at night time, which could lead to disturbed night sleep and reduced working capacity. The duration of these symptoms is in average five years but in some women they may last for decades. Although vasomotor symptoms are clearly related to decreasing oestradiol levels, the exact mechanism behind the symptoms is not known. The theory is that increased secretion of gonadotropins (FSH and luteinizing hormone) from the pituitary makes thermoregulation less stable via changed neurotransmitter production in the brain, mainly the hypothalamus. Such neurotransmitters are e.g. vasoactive peptides, endorphins and noradrenalin. The flushes could be seen as efforts to rapidly change the body temperature when the set point has been suddenly lowered.

The decreasing oestrogen production after menopause not only affects thermoregulation but also causes dryness of the urogenital tract with increased risk of urinary tract infections and pain during sexual intercourse. Oestrogen is also of importance for maintenance of bone mass and menopause is associated with increased bone loss and risk of fragility fractures in the spine, radius and hip. Other problems that are associated with menopause

are increased risk of cardiovascular disease and musculoskeletal morbidity. However, depression and cognitive disorders seem not to be causally related to menopause.

Hormone replacement therapy

For decades now, hormone replacement therapy (HRT) with oestrogen has been employed to relieve menopausal symptoms such as flushing, sweating and sleep disturbances, as well as for prevention of osteoporosis and related bone fractures. Oestrogen alone stimulates the endometrium to proliferation, which in the long-term could lead to cancer development. The addition of progestins (synthetic progesterone) to the oestrogen therapy counteracts the risk of uterus cancer completely. Therefore, all women with intact uterus should be treated with combined oestrogen and progestin therapy. However, symptoms of vaginal dryness only could be treated with local oestrogen. This kind of treatment has hardly any systemic effects and does therefore not need addition of progestins.

Oestrogen is very effective treatment of vasomotor symptoms and there is no other as effective therapy. However, randomized and epidemiological studies during the early 2000s reported that particularly combined oestrogen- progestogen HRT in postmenopausal women increased the risk of breast cancer, as well as cardiovascular disease and thrombosis. Consequently, the benefits versus risks of such treatment have been discussed extensively and new guidelines proposed. Importantly, a woman's age or the period that has elapsed since her menopause appears to influence the benefit-risk ratio in this connection. Later studies have clearly demonstrated that the risk of cardiovascular disease is not increased but rather decreased if therapy starts early in relation to menopause. Still, the risk of breast cancer is slightly increased after about five years of treatment.

Although there is strong scientific evidence that HRT increases bone mineral density and protects against vertebral and hip fractures, this therapy is no longer first-line treatment for prevention of osteoporosis and fractures. The reason is that the treatment needs to continue for a long time (more than five years) and the effect wears off quickly after stop of treatment.

The current opinion and recommendations by professional organizations are that HRT provides highly effective alleviation of vasomotor symptoms and that the risk-benefit ratio is favorable in otherwise healthy women if treatment is initiated shortly after onset of menopause and limited to approximately five years. However, in some women the treatment is contraindicated, such as those with undiagnosed vaginal/uterine bleeding, breast cancer, on-going cardiovascular disease and severe liver disease. For these women alternative treatments and strategies are important.

CHANGES IN BODY COMPOSITION AND PHYSICAL PERFORMANCE AT MENOPAUSE

Weight gain is common during the menopausal transition and longitudinal studies have demonstrated an increase in total and abdominal fat and a decrease in lean body mass. These changes have been observed as early as 3-4 years prior to the onset of menopause and to remain relatively stable for at least 1-2 years after menopause.

At present, little is known about the relationship between eating and physical activity, on the one hand, and oestrogen depletion and subsequent cessation of ovarian function in women, on the other. It is therefore difficult to separate age-related changes in body composition from hormonal changes at menopause. However, menopause per se has been associated

with reductions in energy expenditure and oxidation of fat that can predispose to weight gain. The reduction in energy expenditure is probably a consequence of loss in lean body mass due to a decrease in physical activity, while the alterations in fat distribution appear to reflect modified metabolism in adipose tissue. Thus, oestrogen promotes female fat distribution by stimulation of the activity of the enzyme lipoprotein lipase in femoral fat tissue, whereas lipolysis is stimulated in abdominal fat tissue. Conversely, oestrogen deficiency and menopause is associated with enhanced accumulation of abdominal fat.

Physical performance may be affected by menopause. Population-based studies including objective measures of physical performance lend support for reduced muscle strength and balance in postmenopausal women compared to premenopausal women of the same age. The cardiopulmonary response to strenuous exercise test is also impaired. Furthermore, longitudinal studies demonstrate significant declines in physical functioning during menopausal transition. There seem to be greater loss in physical performance in women who have undergone surgery to remove uterus and the ovaries compared with natural menopause. There is no evidence that HRT protects against impaired physical performance in menopausal women.

HEALTH BENEFITS OF PHYSICAL ACTIVITY IN POSTMENOPAUSAL WOMEN

Regular exercise of moderate intensity is healthy at any age but is particularly important in women after the age of 50 when changes in body composition become more apparent and the risk of disease increases. Physical inactivity is likely a greater risk factor for older individuals than for younger ones. Over the years, both women and men tend to gain weight, decline in muscle mass and muscle strength. In women, the risk of our most common diseases, such as cardiovascular disease, type 2 diabetes and osteoporosis, increases after menopause. Today there is evidence that regular physical activity counteracts climacteric symptoms, changes in weight, body composition and the risk of developing common chronic diseases associated with menopause (Figure 2 and 3).

Figure 2. Rubberband exercise for back- och shouldermuscles.

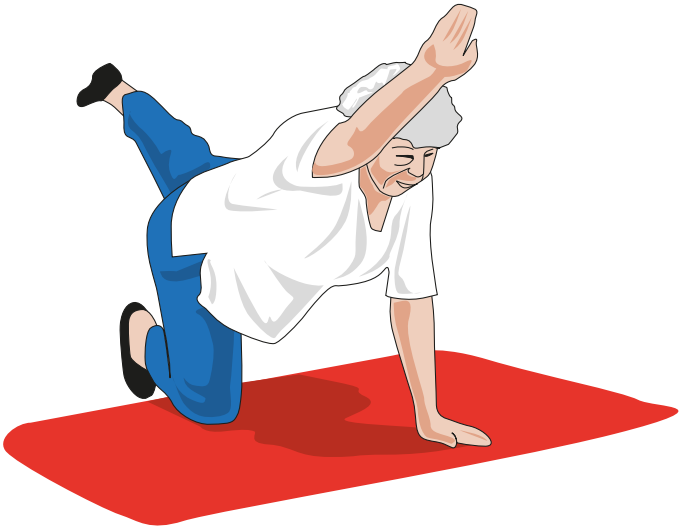

Figure 3. Diagonal arm- and legstretch.

Climacteric symptoms

Age of natural menopause seems not to be affected by exercise. However, regular physical exercise may influence many of the classic climacteric symptoms (except urogenital symptoms) to various degrees. Thus, epidemiological data have shown an association between more physical activity in leisure time and less hot flushes and more favorable sleep quality among postmenopausal women. Furthermore, several, although not all, randomized controlled trials have demonstrated that regular aerobic training decreases hot flushes, night sweats, mood swings, irritability and improves sleep quality in sedentary postmenopausal women. The underlying mechanism may be exercise-induced increase in hypothalamic ß-endorphin, which could stabilize thermoregulation known to be disturbed during menopausal hot flushes. Classic climacteric symptoms could be treated with exogenous oestrogen. However, this treatment implies a long-term increased risk of breast cancer, and therefore alternative managements, such as exercise programs are needed.

Obesity

Menopause-related weight gain and increased abdominal fat accumulation have major cardiovascular and metabolic health risks. Long-term prospective clinical trials have demonstrated that combined lifestyle dietary and physical activity programs prevent weight gain during menopausal transition in healthy women. For instance, a 5-year randomized lifestyle intervention aiming at modest weight loss by low-fat diet and increased physical activity expenditure to the level of 1000-1500 kcal/week resulted in a mean weight change of -0.1 kg compared to an average weight gain of 2.4 kg in the control group.

Furthermore, most randomized controlled studies have shown that exercise alone (e.g. walking, other aerobic training, resistance training, strength training or combinations of these) results in modest reduction in body weight among overweight and obese postmenopausal women. Supervised exercise seems to be more effective than self-initiated physical activity. The mechanism of weight loss is attributed to increased energy expenditure and greater resting metabolic rate. However, the effect of exercise on intra-abdominal body fat is more pronounced and dose-dependent. The most effective exercise for losing body fat was 30-60 min of brisk walking or other aerobic training at 45-75% of VO_2max on 3-5 occasions/week. Exercise seems to reduce body fat more effectively in obese than in non-obese

individuals. Unlike diet, exercise also increases cardiorespiratory fitness levels, which imply additional beneficial health effects than weight reduction as such. Furthermore, exercise prevents the loss of lean body mass secondary to dietary restriction.

The best results for weight loss are accomplished by combined interventions of aerobic training and weight-reducing diet in overweight/obese postmenopausal women. A one year-long randomized study showed 10.8% weight loss by combined lifestyle intervention, 8.5% by diet alone (low-fat diet) and 2.4% by exercise alone (moderate-vigorous aerobic physical activity). Unfortunately, longer lifestyle intervention trials (> 30 months) have failed to show sustainability of lifestyle changes.

Cardiovascular disease

Postmenopausal women, irrespective of age have approximately doubled incidence of cardiovascular disease, primarily coronary heart disease, than premenopausal women of the same age. This well-known association has been attributed to decreased oestrogen levels after menopause since oestrogen exerts several beneficial effects on the cardiovascular system, including vasodilatation and by promoting a favorable serum lipid profile. Regular exercise generally improves cardiovascular function, promotes a favorable lipid profile and body composition, and reduces blood pressure and levels of stress hormones. Exercise may therefore counteract the increased risk of cardiovascular disease associated with menopause.

Randomized clinical trials lend support for significant improvements in cardiovascular risk factors by increased physical activity in postmenopausal women, including cardiorespiratory fitness, body composition, blood pressure, endothelial function[1] and blood lipids. The greatest decrease in risk factors was observed in women with the highest metabolic risk profile. Furthermore, a dose-response relationship has been demonstrated between the amount of aerobic exercise and numerous coronary heart disease risk factors in women after menopause. Randomized studies have also shown favorable effects on cardiovascular risk factors by resistance training, including blood lipids and inflammatory biomarkers independent of body mass index (BMI) alterations in postmenopausal women.

Moreover, evidence-based observational studies support that physical activity reduces the outcome of overall cardiovascular disease, coronary heart disease and stroke in postmenopausal women in a dose-dependent fashion. Brisk walking or vigorous exercise of at least 2.5 hours per week reduces the risk of cardiovascular disease approximately by 30%. Even walking one hour per week was associated with reduced risk of cardiovascular disease outcome. However, there are still no long-term randomized clinical trials demonstrating that exercise reduces the risk of cardiovascular disease in postmenopausal women.

Coronary heart disease remains the major cause of mortality among women of postmenopausal age. Large prospective observational studies with up to 40 years of follow-up have shown that long-term regular physical activity significantly decreases the risk of all-cause mortality but in particular mortality from cardiovascular disease in women. A 30% lower risk of total mortality was observed in women reporting high physical activity corresponding to vigorous activity two or more times per week or moderate physical activity more than four times per week.

1 The endothelium is the name of the single layer of cells that lines the blood vessels. Endothelial function involves regulation of blood pressure and blood clotting."

Insulin resistance and type 2 diabetes mellitus

Postmenopausal women have a higher risk for impaired glucose tolerance (prediabetes) and type 2 diabetes mellitus than premenopausal women. The increase in body fat associated with menopause and reduced physical activity may predispose these women to an insulin-resistant state. Furthermore, diabetes increases the risk of heart attack more than fivefold in women. Prevention of diabetes is therefore one of the major health issues in postmenopausal women.

Large observational studies have shown reduced incidence of type 2 diabetes by physical activity like walking in postmenopausal women. Furthermore, randomized clinical trials have demonstrated that regular aerobic training, even without significant weight loss, can improve insulin sensitivity and glucose tolerance in postmenopausal women, particularly in those with impaired glucose tolerance. These favorable effects by aerobic exercise have been attributed to various mechanisms including reduction in abdominal fat and improved glucose metabolism in skeletal muscle. However, the optimal dose and type of aerobic exercise for prevention and treatment of glucose intolerance remains unknown.

Resistance training may induce beneficial changes in insulin sensitivity by muscle mass development. However, in contrast to aerobic training, the effects of resistance training on metabolic parameters in postmenopausal women are not conclusive. Some studies suggest that the combination of resistance and aerobic training results in greater improvements of glucose tolerance and insulin sensitivity than aerobic training alone. Other studies report no significant metabolic effects by resistance training. Furthermore, there is no evidence of additional improvements in glucose homeostasis by resistance training in combination with diet.

The most effective lifestyle programs for diabetes prevention and restoring normal glucose regulation seem to be combined diet and aerobic exercise. The current international recommendations are lifestyle programs promoting 5-10% weight loss and moderate physical activity of at least 150 min/week in patients with prediabetes.

Osteoporosis

Bone is a metabolically active tissue, constantly undergoing remodeling by formation and resorption. Several factors are known to influence this process in adulthood. Besides hereditary factors, hormones, body weight and physical activity influence bone mass.

Estrogen is important for maintenance of bone mass by anti-resorption activity. In women, reduced oestrogen levels following menopause are associated with accelerated bone loss which in some cases may lead to osteoporosis, a disease characterized by skeletal impairment with increased bone fragility and susceptibility to fracture. It is estimated that 50% of all women over the age of 50 will suffer from an osteoporotic fracture during their lifetime.

Mechanical loading of increasing intensity and frequency promotes the formation of bone. This is supported by a positive correlation between exercise and bone mineral density (BMD), whereas physical inactivity is associated with reduced bone mass. A high lean body mass is also related to high BMD since with increasing lean mass, the skeleton has to adapt to supporting a larger and stronger muscle mass. Furthermore, prospective cohort studies show a negative relationship between physical activity and the risk of hip fracture in postmenopausal women.

From randomized controlled studies there is evidence of a small but significant dose-dependent positive effect of exercise on BMD for the neck of femur, as well as the spine in postmenopausal women. Intense high impact strength training is most effective for prevention of bone loss and not endurance exercise, which is instead of importance for prevention of cardiovascular disease. The effect of exercise on cortical and trabecular bone seems to be similar. It is considered that exercise is a safe and effective way to prevent bone loss in these women. However, it is still not proven that exercise programs decrease the risk of osteoporotic fractures in postmenopausal women.

Sarcopenia

There is a clear loss of muscle mass with ageing but the role of menopause for the onset of muscle loss in women is controversial. Furthermore, the effect of HRT on muscle mass in postmenopausal women is contradictory.

The normal age-related loss in muscle mass is named sarcopenia. It implies reduced muscle mass due to denervation of motor neurons and loss of muscle fibers, as well as reduction in muscle fiber size. The changes are most pronounced for fast type II fibers. The reduction in muscle mass seems to start in early adulthood and accelerate after the age of 50 years. It is estimated that the reduction in muscle cross-sectional area is about 40% between the age of 20 and 80 years of age. This loss of muscle mass is accompanied by an increase in non-contractile tissue such as collagen and fat. Muscle strength decreases at a rate of 1-1.5% per year from 60-65 years of age. Suggested causes of sarcopenia include changes in the hormonal status, decreased levels of physical activity, reduced protein intake and increased oxidative stress. Sarcopenia has been associated with functional impairment during daily activities (e.g. rising from a chair, stair climbing) and reduced postural balance control leading to increased risk of falling and fractures.

Aerobic exercise in overweight and obese middle-aged and older adults with sarcopenia does not significantly increase muscle mass but the addition of aerobic exercise to energy restriction is effective in preserving fat-free mass and muscle strength in older adults trying to lose weight. Resistance training on the other hand, has been shown to increase muscle mass in older adults and to be effective in counter-acting age-related muscle loss and strength. Strength training in elderly individuals evokes muscle hypertrophy, adaptive changes in neuromuscular function and increased muscle strength, which leads to improved functional capacity. A randomized study showed that resistance exercise and balance exercise produced significant improvements in physiological and functional risk factors for falls and disability in women aged 70-90 years with a recent history of falls. Resistance training seems to offer benefits over endurance training for improving muscular strength and functional abilities.

Breast cancer

Breast cancer is the most common cancer in women and the incidence has increased in the Western world during the last 20 years. The estimated lifetime risk of breast cancer is about 11% in a Swedish woman and the median age of onset is 65 years. Despite the increasing incidence of breast cancer, the mortality rate is stable or decreasing. This may indicate that the disease is diagnosed at an earlier stage or/and the treatment has improved. The prognosis is in general good and the 10-year relative survival rate is more than 80%.

Several risk factors for breast cancer have been identified including heredity, hormonal and lifestyle factors. Physical activity has been shown to be a protective factor. There is

epidemiologic evidence of a 25% risk reduction of breast cancer among physically active compared to inactive women and a dose-response relation has been demonstrated. The greatest reductions were observed for recreational activity, for activity of moderate to vigorous intensity and physical activity performed regularly. Furthermore, there is evidence for stronger effect of physical activity in postmenopausal women than younger women and in lean women compared to those with high BMI. Physical activity has also been shown to improve breast cancer survival.

A number of plausible mechanisms have been suggested to explain the influence of physical activity on breast cancer risk. These may involve favorable changes by physical activity on adiposity, sex hormone levels, insulin resistance and chronic inflammation.

Depression and mood symptoms

Depressive symptoms and disorders are common during menopausal transition although no direct association has been proven. Women who experience severe vasomotor symptoms (hot flushes, night sweats) are more likely to report depressive symptoms than other women. It is believed that vasomotor symptoms may disturb sleep, and sleep disturbances cause negative mood. It has been proven that perimenopause increases susceptibility to depression, particularly in women with previous vulnerability.

There is a relationship between depression and physical activity in the way that a lower level of physical activity is associated with a higher incidence of depressive symptoms in postmenopausal women. Randomized studies have shown that aerobic training results in improvements in depressive mood in women with menopausal symptoms. Furthermore, studies have demonstrated a positive dose-response relationship between physical activity and improvements in mental health. A recent Cochrane report concluded that exercise is moderately effective for reducing symptoms of depression. The suggested mechanism is that exercise stimulates the release of mood-elevating neurotransmitters such as endorphins and serotonin in the brain.

MECHANISMS FOR HEALTH BENEFITS OF PHYSICAL ACTIVITY

In the various sections of this text a multitude of beneficial effects are described when beeing physical active. The mechanisms, which may explain why skeletal muscles contribute to the health of people, have been a focus area for research since Morris´s study in the 1950s, demonstrating that the bus conductors on ”double-deckers” in the London bus system had fewer heart infarctions than the drivers. It became soon common in the field to talk about ”the exercise factor” and in the last 15 years not only one but many, many substances have been identified to be produced by contracting skeletal muscles. Products, which are released to the blood stream and affect functions of other tissues and organs in the body, just like hormones, with the potential to elicit health related effects. They are named myokines.

Many of the substances are cytokines and one of the best studied is interleukin-6 (IL-6). The gene encoding for Il-6 in skeletal muscles is quickly activated during aerobic exercise. IL-6 is produced and released to the blood. Several tissues have receptors for IL-6 and when this cytokine is bound to its receptor, insulin sensitivity is increased and more glucose is taken up by the cells. IL-6 also elevates fat oxidation in many tissues. An issue has been that IL-6 is produced by white blood cells and causes inflammation. It took some years to

find out how the same cytokine could have so different effects. The problem was solved, when it was found that white blood cell derived IL-6 was slightly different in its amino acid composition compared to skeletal muscle cell IL-6. It is only this latter form improving the metabolic functions of the human body. Another cytokine is IL-15, which also is produced by active muscles and especially by resitance training. It has a strong local anabolic effect but acts on the fat mass by blocking lipid depostion in the cells, thereby limiting obesity.

There are also neuroactive myokines. One well studied is brain derived neurotrophic factor (BDNF), which is, in spite of its name not only produced in the brain but in contracting muscles as well. BDNF stimulates the function of peripheral nerve cells but also tissue metabolism. The big question, but still unsolved, is whether BDNF can pass the blood-brain barrier. Data on humans are so far negative, but there are speculations by many that BDNF could be ”the link” between exercise and for example lower frequency of dementia, as found in epidemiological studies.

The latest myokine being described is iriscin. It is proposed to affect our fat cells and cause them to produce heat rather than just an energy store. Just like in many wild animals living in the cold, where brown fat is a ”heater” in the body. Those, who first identified iriscin are now studying long term effects of this myokine. Their hope is to use iriscin to turn the fat mass of obese people to ”brown fat behavior” and thereby reduce obesity in an overweight population.

The above may sound speculative. In part it may be true and only further research can give final answers. It will take time as this type of research is time demanding. Muscle-produced IL-6 in humans was first described year 2000, and now 14 years later its role is well documented. The area is ”hot” in all parts of the world. The group performing the study on iriscin is already discussed as possible candidates for the Nobel Prize, if their hypothesis is right. Thus, in the coming years we will have answers to many of the basic questions, related to why our muscles and exercise are so important for our health.

RECOMMENDATIONS

Regular physical activity could be recommended for all healthy women after menopause. There is strong evidence that regular exercise improves overall physical and mental health and reduces the risk of age- and menopause-related physical changes and a number of chronic diseases (Table 1). However, there is a great need of knowledge about how training should be initiated to cause high compliance, and how to support a sustained change in exercise habits.

Several physical activity guidelines have been published in the last decades. In 2007, the American College of Sports Medicine (ACSM) in conjunction with the American Heart Association (AHA) published physical activity recommendations for older adults. These recommendations were revised in 2009, and later on guidance for prescribing individualized exercise for healthy adults of all ages was published in 2011. Here are the summarized ACSM recommendations for healthy adults:

- Aerobic exercise, e.g. brisk walking, aquatic exercise and stationary cycle exercise, of moderate-intensity for a minimum of 30 min on five days each week or vigorous-intensity aerobic activity for a minimum of 20 min on three days each week.
- Resistance exercise of the major muscle groups, such as weight training programs and stair climbing, of moderate or vigorous intensity two to three times per week.

- Neuromotor exercise, involving balance, agility and coordination two to three times per week.
- Flexibility exercise for each of the major muscle-tendon groups, a total of 60 sec per exercise on at least two times per week.

The guidelines note that additional benefits occur as the amount of physical activity increases through higher intensity, frequency and/or longer duration. On the other hand, even lower levels of physical activity than recommended could be beneficial for health. Therefore, if adult individuals are not able to meet the above exercise targets due to age or disabilities they are recommended to be as physically active as their conditions allow.

Although there are no official European recommendations for physical activity, both the World Health Organization and the British Association of Sport and Exercise Sciences have confirmed the recent US guidelines.

Risk of exercise

Although regular exercise decreases the risk of chronic diseases including cardiovascular disease, those who have coronary heart disease are at greater risk for myocardial ischemia and infarction during vigorous physical exertion. The risk is particularly increased by unaccustomed physical exercise in sedentary individuals but decreases with increasing regular exercise. It is important to identify those at risk for cardiovascular disease and pay attention to forewarning signs and symptoms. Consultation with a medical professional is recommended for those with symptoms or known cardiovascular disease.

Elderly people may be at increased risk of musculoskeletal injury, which is the most common exercise-related complication. The type and intensity of the exercise are important factors for the risk of injury. Walking and moderate-intensity physical activities are associated with a very low risk of musculoskeletal complications, whereas jogging, running and competitive sports are associated with increased risk of injury. General recommendations to reduce musculoskeletal injury are warm-up and cool-down stretching and gradual progression of exercise volume and intensity.

Table 1. Evidenced-based effects of regular physical activity in postmenopausal women.

Parameter	Effect	Health outcome
Body weight	Decreased	Reduced weight and risk of obesity, particularly the abdominal type
Blood pressure	Decreased	Reduced risk of hypertension, coronary heart disease and stroke
Serum lipids	Improved	Reduced risk of hyperlipidemia and cardiovascular disease
Oxygen uptake	Increased	Improved cardiorespiratory fitness
Muscle mass and muscle strength	Increased	Reduced risk of cardiovascular disease, sarcopenia, muscle weakness
Insulin resistance	Decreased	Reduced risk of type 2 diabetes and metabolic syndrome
Bone mass	Increased	Reduced risk of osteoporosis and hip fracture
Balance	Improved	Reduced risk of falling

Climacteric symptoms	Improved	Reduced climacteric symptoms and improved life quality
Mood	Improved	Reduced symptoms of depression

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