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PREVENTION OF BONE LOSS AND OSTEOPOROSIS – AN INFORMATION PACKAGE

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The purpose of this thesis was to create a self-management guide to help prevent bone loss amongst people who are at risk of developing osteoporosis. This can be accomplished through using evidence based, research proven facts that have been combined into an easy-to-follow information package, making all the information easy to access.

The guide aims to increase the knowledge on how to achieve and maintain good bone health. It also explores the factors leading to an increased risk of osteoporosis. Therefore, it allows for individual learning as well as provides the reader with tools to use for assessing their own risks of developing osteoporosis.

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1 INTRODUCTION

Osteoporosis is a skeletal disease, characterized by a decrease in bone mass predisposing to fractures. There are some 400 000 people in Finland suffering from decreased bone mass (website of the Finnish Osteoporosis Association, 2005), causing an estimated 30 000- 40 000 osteoporotic bone fractures annually (website of the Current Care Guidelines, 2006). Women are at higher risk, as 40 % of women sustain an osteoporotic fracture during their lifespan. Osteoporosis is considered to contribute to more than half of the fractures sustained by women over 45 years of age (website of the Finnish Osteoporosis Association, 2005).

Due to the high prevalence of osteoporosis especially amongst postmenopausal women it is obvious that bone loss prevention is of great importance. Therefore a suitable information package would be beneficial for those who are at risk of developing osteoporosis as well as those who already suffer from the disease.

2 PURPOSE AND AIM OF THE THESIS

The purpose of this thesis was to create a self-management guide to help prevent bone loss amongst people who are at risk of developing osteoporosis. This can be accomplished through using evidence based, research proven facts that have been combined into an easy-to-follow information package, making all the information easy to access.

The guide aims to increase the knowledge on how to achieve and maintain good bone health. It also explores the factors leading to an increased risk of osteoporosis. Therefore, it allows for individual learning as well as provides the reader with tools to use for assessing their own risks of developing osteoporosis.

3 OSTEOPOROSIS EXPLAINED

3.1 Osteoporosis

Osteoporosis is a skeletal disease that jeopardizes bone strength, leading into an increased risk of fractures. Furthermore, reduced bone mass along with micro-architectural decline of bone tissue leading to low bone mineral density. These, along with other structural changes, lead to an increased risk of low trauma fractures (Tuck & Datta 2007, 521). Most osteoporotic fractures occur in the vertebral body, hip, forearm, humerus, tibia, pelvis and ribs. Low trauma distal forearm has been recognized to be a typical sign of post-menopausal osteoporosis among women. In fact, 50 % of women suffering of this type of fracture have osteoporosis (Tuck & Datta 2007, 523). On the contrary, hip fracture tends to cause considerable disability among men, with only 21% living independently a year later, 26% receive home care and 53% are hospitalized (Tuck & Datta 2007, 523). Osteoporosis is diagnosed through measuring bone mineral density, and it is done using dual X-ray absorptiometry (DXA). It al-

lows an objective and accurate diagnosis of osteoporosis before fractures occur (Tuck & Datta 2007, 525).

3.2 Prevalence

Osteoporosis is a national health problem that can be compared to coronary artery disease, hypertension or diabetes (website of the Finnish Osteoporosis Association, 2013). There are some 400 000 people in Finland suffering from osteoporosis, and approximately the same amount of people suffering from osteopenia, which also refers to bone loss, but less than in osteoporosis (Cashman 2002, 169). Osteoporosis is considered to be related to 30 000 – 40 000 bone fractures annually (website of the Current Care Guidelines, 2013). Such fractures typically include hip and wrist fractures, as well as vertebral fractures of the spine. Hip fractures are considered to be the most difficult of the three, with 6000- 7000 incidents annually. Hip fractures are considered difficult, because treatment always requires hospital care, and half of the patients never fully restore their functional ability (website of the Finnish Osteoporosis Association, 2009).

Osteoporosis is not only considered to be a public health problem in Finland, but also worldwide. Currently an estimated 200 million people is considered to suffer from osteoporosis (website of the International Osteoporosis Foundation, 2013), and especially ageing populations will be responsible for a rapid increase of the prevalence of osteoporosis in postmenopausal women (Landfeldt et al. 2011). While osteoporosis is mostly considered to be a major epidemic in the industrialized countries, it has been estimated that by 2050 already half of hip fractures occur in Asia. Similarly, the greatest increase in the prevalence of hip fractures may be expected in Middle East, Asia and Latin America where life expectancy can be predicted to increase the most in the future (website of the International Osteoporosis Foundation, 2013).

4 THE RISK FACTORS AND EFFECTS OF OSTEOPOROSIS

4.1 Physically inactive lifestyle

Exercise and physically active lifestyle has an important role in bone health. Especially, when in growing age, the bone´s ability to adapt to mechanical loading is seen to be a lot greater than after maturity (Kontulainen 2002, 24). Physically inactive lifestyle results in bone loss and fractures not only amongst elderly people, but also bedridden patients and young people. It has rapidly become a serious healthcare problem worldwide(Klein-Nulend et al 2012, 278).

Bone remodeling is a process that goes on constantly throughout lifetime. That process occurs through coordinated action of osteoclasts and osteoblasts in basic multicellular units. The amount and the level of activity of osteoclasts and osteoblasts depends on many factors, such as hormones and cytokines, as well as the signaling molecules produced locally at the site of mechanical stimuli. Therefore, whether the process of bone remodeling leads to loss or gain in bone mass depends on the amount of mechanical stimuli, namely physical activity (Klein-Nulend et al 2012, 278).

Regular physical activity during growing age is important for bone health due to its improving effect on bone mass (Bielemann et al. 2013). Moreover, there is a positive correlation to bone mineral density of the radius and hip and total hours of physical activity in boys and girls between 5-14 years of age. It has also been found, that the effect of body weight on bone mineral density is because of the load that is put on weight-bearing bones. Therefore, children who are physically inactive and underweight have increased risk of developing low bone mineral density (Boot et al. 1997, 61).

Muscle weakness due to physical inactivity is known to be common amongst elderly people. Older people are habitually stiffer and less co-ordinated in gait than younger people. Furthermore, as people age their posture control, reflexes, muscle strength and tone, and height of stepping all grow weaker. Therefore, older people have im-

paired ability to avoid a fall in case they come across something that may affect their balance (Rubenstein 2006, 38).

Immobilized, or bed rest patients are at risk of losing as much bone in a week, as they would otherwise lose in year. Therefore, immobilization should be avoided. Weight bearing exercises are important for an osteoporosis patient, though the optimal amount is yet unknown (Kanis et al. 2008). Exercises designed to improve muscle strength need to be intense enough, also balance training should be an important element in any exercise program that aims at prevention of falls. The exercises need to be performed regularly, as continued participation can lead to lowered falls risk up to two years (Gardner et al. 2000).

As a conclusion, inactive lifestyle increases osteoclastic activity of the bone, resulting in loss of bone mineral density. On the contrary, weight bearing exercise increases osteoblastic activity leading to gain in bone mineral density. Therefore, weight bearing exercise such as daily walking should be recommended to all postmenopausal women, as it has been proven to slow down the normal bone loss experienced by women that age (de Villiers 2009, 75-76).

4.2 Alcohol

Drinking alcohol is considered to be a major lifestyle factor increasing the risk of getting osteoporosis. However, there is some evidence suggesting that moderate use of alcohol may actually help maintain bone mass (Ilich et al. 2002, 540). On the contrary, chronic heavy alcohol use is known to be well associated with osteoporosis as well as osteoporotic fractures. Chronic alcohol users are known to be involved with low dietary calcium and other nutritional deficiencies, low body weight, tobacco smoking and high caffeine intake, all of which are well known risk factors for bone loss and osteoporosis (Ganry et al. 2000, 773).

There may be several reasons why moderate use of alcohol affects bone mass beneficially. Alcohol stimulates aromatization of androgens to estrogens, a process which

in postmenopausal women is the only source of estrogens. Furthermore, moderate alcohol use may inhibit osteoclasts that are involved with bone resorption (Ilich et al. 2002, 540). On the contrary, chronic alcohol use affects bone health negatively. The reason for that is alcohol´s ability to inhibit bone turnover, stimulate calcitonin production and reduce the level serum parathyroid hormone (Maurel et al. 2012, 413).
The amount of alcohol used is related to the risk of getting a hip fracture. People drinking one drink or less per day have the lowest risk of hip fracture. Overall, persons using moderate or small amounts of alcohol have lower risk of hip fractures than heavy drinkers. However, there may be other factors affecting the amount of hip fractures among heavy drinkers, for example the increase of falls (Berg et al. 2008).
Despite all the research proven evidence, it may be hard to differentiate the factors behind study results, as Ganry et al. (2000, 778) clearly brought up. The challenges are similar to investigating the effect of tobacco on bone health, the participants may vary in socioeconomic spectrum or physical activity levels. Also many studies lack heavy drinkers, making it difficult to make conclusions of the data gathered (Berg et al. 2008).

4.3 Smoking

Tobacco smoking is known to be a risk factor for osteoporosis. It has also been linked with low bone mass and an increased risk of fragility fractures. Smoking is seen to increase antiestrogenic effects in women. As a result, smoking women may experience early onset of menopause as well as osteoporosis. Furthermore, smokers are observed to have reduced protective effects of calcium from their nutrition when compared with nonsmokers (Akhter et al. 2005, 319). Besides decreased calcium absorption, tobacco smoking has also been seen to interfere with the absorption of vitamin D (Krall & Dawson-Hughes, 1999). In addition to that, smoking leads to increased levels of hormone cortisol, which clearly plays a negative role on bone health especially in the first years after menopause (Osella et al.2012).

Even though smoking is recognized as a risk factor for bone loss and osteoporosis due to various mechanisms, Law & Hackshaw (1997, 844) stated that their importance remains unclear.
Besides the effects on bone health, tobacco smokers tend to be weaker, have poorer balance and impaired neuromuscular performance, all of which may give rise to an increased risk of falls (Wong et al. 2007, 236).

4.4 Low calcium and vitamin D

Calcium is a vital component in building healthy bones. Especially during growing age, sufficient amount of calcium from nutrition is critically important for building healthy bones. Furthermore, gathering adequate amount of bone mass during growth is crucial in preventing osteoporosis later in life (Black et al. 2002, 675). In Western countries, more than half of the calcium in children´s nutrition comes from milk or other daily products (Subar et al. 1998, 918). People that used plenty of milk or other dairy products in their nutrition during childhood, tend to have stronger bones than people who did not (Teegarden et al. 1999, 1017).

Low intake of vitamin D during childhood can cause rickets, and also prevent children from meeting the height and bone mass they were genetically supposed to (Holick 2004, 1682). However, during adulthood vitamin D deficiency can cause secondary hyperparathyroidism, a process which mobilizes calcium from the skeleton reducing bone mass, and ultimately increases the risk of getting osteoporosis (Holick 2004, 1682-1683). Vitamin D deficiency disturbs calcium as well as phosphorus metabolism. Furthermore, low intake of vitamin D causes decreased consentrations of ionized calcium (Holick 2004, 1683).

4.5 Effect of osteoporosis on mental health of a patient

Osteoporosis is most commonly seen as a musculoskeletal disease and most attention is put on the physical challenges it brings up. However, it is critically important to

realize the psychological aspect of this disease along with the physical challenges. Especially in case of several fractures, osteoporosis tends to put a major impact on the emotional well-being of an osteoporotic patient. A patient may become anxious because of the worry of fractures that may occur in the future. This typically leads to physical inactivity and sedentary lifestyle (Gold 1996, 185), which does nothing to help them in terms of treating the disease, as discussed earlier in this thesis (chapter 2.2.1). In fact, regular weight-bearing exercise is a key element in improving bone health and thus should be included in any adequate treatment plan of osteoporosis, as discussed in depth later in this thesis (chapter 5.3).

Sometimes osteoporotic fractures may lead to depression, and patients have reported of having sleep problems, lack of appetite, feeling of hopeless about the future and the lack of understanding to their problems from others. As a result, many patients suffer from decrease in their self esteem due to the physical changes in their body as well as the functional limitations caused by the disease. Osteoporosis also affects greatly in the patients social life, and often patients need help from their friends and family members due to the impairments caused by the disease (Gold 1996, 186).

5 TREATMENT

5.1 Exercise

The build-up of bone starts early in life, as the ability of bone to adapt to mechanical loading is greater than later in life (Kontulainen 2002, 24). Optimization of peak bone mass during adolescence ensures better bone health later in life. However, bone mass decreases with ageing. Therefore, regular weight bearing exercise is a good way to increase peak bone mass. Good sports for weight bearing exercise include aerobics, jogging, jumping and other sports during which impact is generated to the skeleton (Hind & Burrows 2006, 15). Studies have proven these sports to be great for producing bone mass (Wallace & Cumming 2000, 13). Overall, athletes are seen to

have more bone mass than people who are physically inactive (Wallace & Cumming 2000, 10).

The increase of physical activity leads to an increase in bone mass. That is because of the increased mechanical loading on the bones. The most common sites where studies have demonstrated the increase in bone mass are the spine and femur (Petranick & Berg 1997, 202). However, even though walking and jogging etc. are important in terms of building a strong skeleton, weight training is an important asset. With weight training added to the exercise routine, it is easier for young women to build bigger peak bone mass before the ages during which bone loss begins. Strength training may help post-menopausal women to delay bone loss and therefore decrease the risk of fracture. In elderly women, weight training helps in building strength as well as balance, and therefore acting as a tool for falls prevention improving their ability to live independently (Petranick & Berg 1997, 207).

As already mentioned, the exercise needs to be done regularly. In their review article, Hingorjo et al. (2008, 80) suggest, that an exercise program consisting of weight bearing exercise as well as resistance training can successfully increase bone mass, when done three or four times each week, 30-40 minutes at a time. However, Heinonen et al. (1999) found some increase in bone mass with regular aerobic step classes done three times per week, 60 minutes at a time.

5.2 Nutrition

Vitamin D is known to be important for normal development and maintenance of the skeleton. Vitamin D deficiency is also known to be related to rickets and osteomalacia. Vitamin D deficiency deteriorates calcium metabolism, osteoblastic acticity, bone remodeling and bone density. Vitamin D deficiency results in impairment of the mineralization phase of bone remodeling and leading to increased amount of the skeleton being replaced by unmineralized osteoid, causing osteomalacia. Normal bone growth and mineralization is dependent on the availability of calcium and phosphate. Vitamin D is an essential prohormone for normal ab-

sorption of calcium from the gut, and deficiency of vitamin D is seen to be more common than isolated calcium or phosphorus and is the leading cause of rickets (Christodoulou et al. 2012).

Vitamin D is available for the body in two ways, as ergocalciferol (vitamin D2) or as cholecalciferol (vitamin D3). Ergocalciferol is derived from plants, and it is converted to 25-hydroxyvitamin D2 (25(OH)D2) by the liver, then to 1,25-dihydroxyvitamin D2 (1,25(OH)2D2 by the kidneys. Cholecalciferol, found from animal sources is converted to 25(OH)D3 then to 1,25(OH)2 D3. Cholecalciferol is only found in a few food sources, and therefore it is often used as a dietary supplement, either alone or together with calcium (Christodoulou et al. 2012). However, the way through which most humans get majority of their vitamin D, is exposure to sunlight. During summer, plenty of vitamin D can be produced in the skin, and stored in the body fat to be mobilized during winter when there is little or no sunlight from which the skin can produce vitamin D (Holick 2004, 364). The ability of the skin to produce vitamin D is dependent on several factors, such as sun incident angle, geographic location, time of the day and season (Wacker & Holick 2013, 115). Furthermore, the amount of outdoor activity affects the amount of vitamin D produced in the skin, as well as the amount of clothing covering up the skin (Parfitt et al. 1982, 1015).

There are only a few foods that contain vitamin D. Good vitamin D sources include oily fish, irradiated mushrooms, egg yolks, cod liver oil, milk and other dairy products that have been fortified with vitamin D (Holick 2004, 1681).

Calcium is a major component for growing, developing and maintaining healthy bones. It accounts for 1-2 % of the human body weight and serves as a major component of mineralized tissue (such as bones). High proportion of the body´s calcium is located in bones, and bones act as a reserve for body´s calcium. The optimal intake of calcium varies throughout different stages of life; the need for calcium is greater during growing age, pregnancy and later in life (Flynn 2003, 851). Furthermore, in humans bone mass increases during childhood and adolescence, and peak bone mass is reached at early adulthood (Flynn 2003, 853). Study results have shown that dietary calcium intake has a positive effect on bone mass in children and adolescents, as well as older people, especially postmenopausal women (Gennari 2001, 550). More-

over, calcium supplementation is seen to reduce bone loss in adults as well as elderly people (Gennari 2001, 550-551). Some studies have proven calcium treatment to improve bone mass, and also reduce fracture incidence in osteoporotic patients (Gennari 2001, 551).

Calcium supplementation reduces bone loss by reducing serum parathyroid hormone (Gennari 2001, 551). However, vitamin D has been recognized to be a key element in the absorption of calcium (Christodoulou et al. 2012), as it increases calcium absorption from the small intestine (Khazai et al. 2008, 110). This is because many of the calcium transport regulating proteins are vitamin D-dependent. Therefore, optimal vitamin D levels are necessary to secure adequate calcium absorption. Without sufficient vitamin D levels, the body is able to absorb only 10-15 % of dietary calcium, whereas with sufficient vitamin D-state, the intestinal absorption increases up to 30-40 % (Khazai et al. 2008, 113).

The best sources for dietary calcium include dairy products (milk, cheese and yoghurts), fish, a few vegetables and fruits. Of these calcium sources, dairy products have the highest bioavailability. The best way to achieve sufficient amount of calcium is through diet, though if there is intolerance of dietary sources, calcium supplements can also be used (Gennari 2001, 556).

5.3 Medication

Osteoporosis medication aims at decrease in bone loss as well as preventing fractures. Vitamin D controls various mechanisms that affect bone health, most important of them being stimulating the intestinal absorption of calcium. It is highly important to achieve adequate intake of vitamin D through supplements due to the fact that only few food sources contain vitamin D. Furthermore, vitamin D is mostly derived from sunlight. However, especially in northern countries such as Finland, there is a decline in sunlight during winter (Avenell et al. 2009, 3).

Bisphosphonate medicines are also widely used in osteoporosis treatment because of their abilities to reduce osteoclasts that cause bone resorption. The advantage of

bisphosphonate use in osteoporosis medication is the fast response, as its maximum effect can be achieved already after 3-6 months (Watts & Diab 2010, 1556).

6 USING THE GUIDE AS A TOOL FOR TREATMENT

This information package can be used to give guidelines regarding certain healthy behavior issues to ensure good bone mass throughout lifetime. It also explores into certain risk factors that need to be acknowledged to avoid the risk of developing osteoporosis. Besides listing all the things that need to be dealt with and the measures that need to be taken, it also gives a deeper explanation to each of the main topics to ensure better learning potential and there is a theoretical and research proven explanation in the theory part of this thesis. The intake recommendation tables for calcium and vitamin D can be found on the website of the National Institute for Health and Welfare. In the theoretical part there will be an explanation for each measure that is mentioned in the self-management guide. The practical implementation will be a booklet consisting of the selected topics that will be explained in Finnish.

7 THE PROCESS OF THE THESIS

Before I was introduced to the idea of writing a thesis concerning osteoporosis, I was struggling to find a topic that would be both interesting and reasonable to work with. In January 2012 I was offered a chance to create an information package for people suffering from osteoporosis. The initial idea was to write this thesis in collaboration with the local osteoporosis foundation. We had a brief discussion with the organization´s representative about the things this work was supposed to cover. We acknowledged the fact that I was headed abroad for a three-month period of clinical practice,

and therefore I was not able to guarantee a deadline or a date by which this work would be ready.

After that meeting I started to go through the effort of making myself more familiar with the disease. I only did a little bit of writing before the clinical practice period abroad. Most importantly I started picking up the topics that I felt were important to be covered in this thesis.

At January 2013, I started to work with my thesis again. However, at this point the local osteoporosis foundation withdrew from the project as I still could not guarantee them a deadline due to me working full-time. Nevertheless, this turned out to be a good thing as after that I had more control over the issues that needed to be covered. It also allowed me to narrow down the thesis quite a bit, and in hindsight the original plan would have been too wide for the scope of this thesis as it included many topics not mentioned in this work.

In the early summer 2013, I managed to produce good amount of text despite the fact that I worked full-time, and that was the point at which the work really started to proceed. I accomplished to produce most of the text before the end of August, and as for the theory part, I made some cosmetic changes to the table of content with the sole purpose of making the thesis more logical.

I decided to leave the layout of the information package plain and simple. The reason for that was two-fold; I lack the computer skills to produce a good looking guide and I do not know anybody with such skill set. So instead of focusing on the looks of the guide, I am hoping that anybody reading the guide would appreciate the emphasis I have put on the amount of information it provides. The work was finished in the middle of September.

8 DISCUSSION

The purpose of this thesis was to provide an information package about osteoporosis for the people already suffering from the disease as well as the ones who are at risk of getting osteoporosis. Osteoporosis is a widespread disease not only in Finland, but also worldwide. Therefore it seems obvious that an adequate bone loss prevention program or an information package would be beneficiary for the people who are at risk of developing osteoporosis or who already suffer from the disease.

This thesis met its initial purpose of combining information about the disease into an easy-to-use package. However, there would be further possibility to enhance the learning experience by creating an information package about exercise that would be more concrete. All the information regarding exercise in this thesis can be considered rather abstract. Therefore, people suffering from osteoporosis would be best served with an information package that includes detailed information about exercise due to it being such a vital component in recovering from the disease.

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