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Introduction

Fragility facture is a condition in which the bone tissue mass and mineral density are reduced, making the bones fragile. This leads to a risk of osteoporosis (Dorner et al., 2008; Järvinen et al., 2008; Lee et al., 2014). Usually, such fractures occur following a slip or fall, typically from a standing or seated position (Järvinen et al. 2008; Lee et al., 2014; Pfister et al., 2014). Fractures of the hip, spine and wrist are the most common fractures caused by osteoporosis. Such fractures can have fatal consequences within a year of the event among patients over 70 years of age (Bakke, 2014; Lönnroos, 2009; Thevenot, 2011). There is an urgent need to identify lifestyle factors that predict fragility fractures because of their profound adverse effect on quality of life (Pfister et al., 2014). This study describes background and lifestyle factors that predict fragility fracture and osteoporosis among patients aged 50 and over.

Background

Several factors are known to increase the risk of fragility fractures. These include age, gender and genetic factors, unhealthy lifestyles with inadequate nutrition and physical activity, smoking, and overuse of alcohol (Lanham-New et al., 2007; Tuffaha et al., 2013). Fragility fractures and osteoporosis are most common among elderly individuals. Several studies have shown that changes in the structure of bone changes are more common women, (Cawthon 2011; Compton et al., 2019; Farford et al., 2015) and that bone becomes weaker and less dense as individuals age (Al-Ani et al., 2013; Angbratt et al., 2007; Chan et al., 2005; Pulkkinen, 2009; Skorupski and Aleander, 2012). A low Body Mass Index (BMI) and use of medication such as psychotropic, anti-arrhythmic, digoxin, or diuretic drugs may increase the risk of falls, especially among older individuals (Iinattiniemi, 2009;

Phelan et al., 2015). Early menopause reduces oestrogen levels in women, reducing the mineral density of the bone (Palombaro et al., 2013, Zhu-Richard and Prince, 2015). Several instruments have been developed to assess the risk of falling among elderly individuals (Fischer et al., 2014, Beaudeart et al., 2019; Phelan et al., 2015), prevention of which may help to maintain their functional autonomy and thereby improve their quality of life and reduce the cost of their healthcare (Fischer et al., 2014).

Nutritional factors can profoundly affect the health of the bones, as well as general health status and the development or prevention of osteoporosis (Ahmadieh and Arabi, 2011; Cashman, 2007). An adequate intake of vitamins and minerals such as calcium, magnesium, phosphorous, vitamin D, potassium and protein is required to maintain strong bone tissues and prevent fragility fractures. Foods rich in these substances include fruits and vegetables (Boeing, 2012), full corn, milk, and dairy products (Lanham-New et al., 2007; Merill and Aldana, 2009; Tuffaha et al., 2013). Consumption of milk and dairy products in particular has been shown to positively affect metabolism in the bones and muscle function (Lanham-New et al., 2007; Merill and Aldana, 2009; Tuffaha et al., 2013). Bone mineral density can be increased by supplementation with calcium and vitamin D (Angbratt et al., 2007).

It has also been shown that physical activity reduces the risk of developing osteoporosis and increases individuals' physical, social, and mental wellbeing (Dorner et al., 2009; Simmonds et al., 2016; Woulde et al., 2013). Regular physical exercise improves the mineral structure and density of the bone, reducing the risk of fractures (Vainionpää, 2007; Nikander, 2009; Nilson et al., 2012; Zhu-Richard and Prince, 2015). The proximal femur is particularly prone to low bone density and preservation of its strength is an important

benefit of physical activity (Nikander, 2009). Physical activity also helps to maintain mobility; Heikkinen (2010) have shown that immobility is a major cause of physical weakness and obesity among the elderly.

The risk of fragility fracture is also increased by alcohol consumption and smoking, especially among smokers whose nutrition is inadequate, who suffer from malabsorption, or who have low bone density (Al-Ani et al., 2013; Cashman, 2007). Nicotine reduces the amount of calcium in bone tissue (Määttä, 2013), increasing the risk of osteoporosis and fracture. Consuming more than two units of alcohol per day is considered damaging to the bones while consuming more than four units of alcohol per day reduces bone tissue formation and increases the risk of fragile fractures. As alcohol consumption also increases the risk of falls, leading to an elevated fracture risk. (Zhu-Richard and Prince, 2015).

There is a need to understand the effect of multiple lifestyle factors that predict fragility fracture and osteoporosis among patients aged 50 and over. To move further in developing health promotion and health improvement interventions, we need to know what kind patient lifestyle education is in the local healthcare.

Methods

Design

The study was a retrospective cohort study examining clinical data from patients with fragility fracture (n=294) treated at a University Hospital in Finland. Data was included in the study from patients who were assessed with the Fracture Risk Assessment tool (FRAX/ https://www.sheffield.ac.uk/FRAX/) during 2006 – 2016. The inclusion criteria were: 1)

patients with fragility fracture; 2) aged 50 years or over, 3) treatment given at the University hospital during years 2011 – 2016.

The data was collected by a nurse specifically trained for the study while interviewing participants about the items of FRAX-questionnaire (Watts, 2011). Additionally, the interview included questions relating to lifestyle, diet (e.g. intake of dairy products) and levels of physical activity during the patients' treatment at the hospital. With the exception of the background questions, all questions on the questionnaire were yes-no questions (Dunniway et al., 2012).

Instrument

The Fracture Risk Assessment tool (FRAX) is a predictor of 10-year fracture risk. It includes background questions relating to the patient's age, gener, and calculated body mass index. In addition, it includes questions about the patient's history of hip fracture, rheumatoid arthritis, use of cortisone, secondary osteoporosis, and bone mass density, as well as lifestyle-related questions about smoking, and alcohol consumption. It was developed to assess the risk of fracture among people between 50 and 90 years of age (Azagra et al., 2012; Bolland et al., 2011).

Ethical considerations

Approval for the study was obtained from the Nursing Director of the University hospital and an appropriate announcement was made to the privacy commissioner. The ethical committee was not required to give a statement for the study. According in Finnish law on the use of the personal register (1999/523) the consent of agreement for the participants is not required (Räisänen et al., 2013). The Finnish constitution has been amended to protect

personal privacy but also includes allowances for the scientific use of personal information (World Medical Association, 2013). The laws relating to the personal register state (199/523) that the register data may be utilized for scientific analysis and statistical purposes (Räisänen and Gissler, 2012).

This work adhered to the principles of the Helsinki Declaration (World Medical Association, 2013). The identity numbers and names of the persons in the register were removed from the research material at the analysis stage. The obtained research material was kept in password protected computer files. The files were destroyed once the study was completed.

Data analysis

The data were analysed using the SPSS Statistics for Windows (version 22.0, IBM, Armonk, NY). Participant background information was analysed using descriptive statistical measures (frequencies, percentages, and means). Differences in background and lifestyle variables were evaluated using the Chi-squared test. Background variables such as age were converted into binary variables based on histograms (by dividing the participants into those above and below the age of 60 in the case of age). Binary logistic regression analysis was used to identify factors predicting fragility fractures. Odds ratio (OR) is used to indicate the value of the logistic regression model; it presents the likelihood of risk or no risk of sustaining a fragility fracture. Results based on logistic regression models are reported in terms of odds ratios (ORs), which represent the likelihood that a given factor is associated with a risk of fragility fractures. In addition, 95% confidence intervals (CI) and p-values were used to characterize the models' output. Statistical significance was determined based on a p-value threshold of $p < 0.05$.

Results

The final clinical data for analysis consisted of 294 participants. The mean age of the participants was 74 years (range 50-104) and most of them were women (91%, n=268). Fifty percent of the participants for whom BMI was calculated had a normal weight (BMI < 25) and 19% (n=47) were overweight or obese (BMI > 30) (Table 1). The mean body mass index (BMI) of the participants was 25. Two thirds of the participants (68%, n=199) reported having osteoporosis. Almost half of the participants (41%, n=121) reported developing osteoporosis between the ages of 65 and 84. Of those who said they were diagnosed with osteoporosis were 64% (n=187) of women and 4% (n=12) of men (Table 1) and 11% of women had undergone early menopause. Most of the patients' fractures had occurred in the wrist 22% (n=101), the hip 21% (n=99), the ankle 14% (n=65), or the vertebrae 13% (n=59). Statistically significant relationships were found between osteoporosis and vertebra fractures (p=0.02).

Patients' lifestyle and osteoporosis

Most of the participants (76%) ate a typical Finnish diet, characterized by a mixture of vegetables, fruits and berries. The diet also includes whole grain cereals, fish, small amounts of red meat and low-fat dairy products. Only a few participants had dietary restrictions such as requiring a lactose-free (17%) or gluten-free diet (4%). Some of the participants were vegetarian (1%) or were on a milk-free diet (1%). Most of the participants ate dairy products regularly (71%) (Table 2). There was a statistically significant relationship between dairy product consumption and diet to the osteoporosis (p=0.02). (Table 2). However, lifestyle factors and the use of dairy products did not predict the likelihood of osteoporosis. (Table 3).

Most of the participants were physically inactive and were not interested in education regarding their physical activity. One third of the participants (31%) reported poor levels of physical activity (Table 2). These participants used mobility aids such as walkers, wheelchairs, or crutches. Even those who did not use mobility aids (31%) were uninterested in education regarding physical activity. There were statistically significant relationships between participant age, physical inactivity, and osteoporosis ($p<0.01$). Physically inactive participants had a higher risk of osteoporosis than those who were physically active ($p=0.04$). Engaging in physical activity and being interested in education regarding physical activity predicted the likelihood of osteoporosis: physically inactive participants were 2.31 times more likely to have osteoporosis than those who were physically active. The variables gender and age also predicted the likelihood of osteoporosis: women were 2.97 times more likely to develop osteoporosis than men. Participants over 50 years of age with early menopause were 3.87 times more likely to have osteoporosis than those under 50 years of age (Table 3).

The majority of the participants (78%) did not smoke. Women (18%) smoked more than men (3%), and 15% of the smoking participants had osteoporosis. There was a statistically significant relationship between physical inactivity and smoking ($p=0.02$). A minority of the participants (10%) drank alcohol regularly; of those, 7% had osteoporosis. Smoking and alcohol use had a statistically significant relationship with osteoporosis ($p<0.01$). (Table2). Smoking and physical inactivity predicted the likelihood of osteoporosis. Physically inactive participants who smoked were 2.02 times more likely to have developed osteoporosis than those who smoked but were physically active. Participants

who smoked had a 2.53–fold higher risk of getting a fracture of the shoulder than non-smoking participants. Smoking and alcohol use did not predict osteoporosis (Table 3).

Discussion

In this study, the background and lifestyle factors predict fragility fracture and osteoporosis among patients aged 50 and over and those were; an early menopause, female gender, smoking, fracture of the shoulder, and physical inactivity, as we know in early studies.

Previous studies have shown that women have a greater risk of osteoporosis and fragility fractures (Chang et al., 2013; Compton et al., 2019; Lee et al., 2014) because of early menopause. The findings of this study support these results. Therefore, health promotion in clinical practise is important and nurses' should educate women with early menopause risk of osteoporosis and discuss their willingness to part of health promotion groups and encourage to make bone mineral tendency test in health care. In additionally, nurse should make this discussion documentation in patient records.

Woman with early menopause have an elevated lifetime risk of fracture, and they have more fractures than those with a later menopause (Gallagher, 2007; Pinkerton and Stovall, 2009.) The first step health promotion is that healthcare staff especially nurses identify to patients who are likely to suffer from osteoporosis and fragility fractures in the healthcare. Based on early studies, low bone mineral density is a well-known risk factor for osteoporosis in both genders. Oestrogen deficiency causes a risk in women (Moreira-Kulak et al., 2000; Riggs et al., 2003) and hypogonadism has a similar effect in men (Conde and Aronson, 2003). According to Compton et al., (2019) there is a knowledge gap with regards to understanding the causes of osteoporosis in men.

The most common fractures among the study participants were wrist fractures followed by hip fractures. This may be explained by conditions created by weather (e.g. winter slippery conditions), and/or the physical activity of the Finnish population. In previous studies, it has been shown that individuals who have previously had a wrist fracture are also at an elevated risk of another fracture (Cauley, 2015; Nordvall, 2007). Reducing the risk of falls and increasing bone health can be further improved by patient health promotion and preventive action with risk group patients. In addition, we have today aid to support physical activity in wintertime as studded shoes, but nurse should remind patient about this.

Additionally, health promotion is needed, because fractures can have strong negative impacts on patients' quality of life, causing pain and depression (Aytekin et al., 2017). Because impacts of fractures on patients' life are apparent, in clinical practise nurses should have time to discuss emotions with patient during hospitalization and educate them to use medication as a painkiller at home after discharge. Such preventative treatments may also reduce healthcare costs.

Nutritional studies have shown that eating foods such as calcium, fruit, vegetables, and protein helps to maintain the structure of the bone (Dorner et al., 2009; Zhu-Richard and Prince, 2015). However, is know, that older people commonly do not consume sufficient vitamin D, calcium, and protein (Pisani et al., 2016). Protein-rich diets promote the absorption of calcium from the intestines and healthy bone metabolism (Singh, 2014). According to Spangler et al., (2011) and Simmonds (2016), calcium supplements prevent osteoporosis but do not reduce the risk of fracture. Potential dietary sources of vitamin D include dairy products and fish (Christianson and Shen, 2013). In this study majority of

patients were older and women, so they have a greater risk of sustaining fractures and impaired or absent bone ossification. Therefore is important in clinical practice especially older care, identify food components and patients medication, to optimise vitamin D, calcium, and protein intake and absorbing. Vitamin D and calcium supplementation have been shown to reduce the risk of fractures and improve muscle activity (Cauley, 2015; Patton et al., 2012; Pfeifer et al., 2009; Zhu-Richard and Prince, 2015). Participants in this study who had low levels of vitamin D, diagnosed osteoporosis, or fragility fractures were prescribed calcium and vitamin D supplements (or just a vitamin D supplement for patients at the University Hospital). Proper intake vitamin D may decrease fractures by maintaining bone health and in Finland, vitamin D intake is important because we have not sun light during winter time. The amounts of calcium and vitamin D in the supplements typically varied between 500-1000 milligrams and 20-40 micrograms, respectively and studies have shown that treatment of osteoporosis in patients who have sustained a fragility fracture reduce the risk of future fractures (Elliot-Gibson, 2004; Hochberg, 2000; Mehrpour et al., 2012).

This study highlights the importance of physical activity in preventing bone loss and osteoporosis, because inactivity was one risk factor for fragility fractures and osteoporosis. Participants who were physically inactivate were found to have an increased risk of osteoporosis, which is also supported by previous studies (Määttä, 2012; Timmer et al., 2009). However, participants of this study were uninterested in education related to physical activity; based on this we need more innovation solution to create a new interventions for clinical practice. In the future, we may organize nurse led health promotion groups using information and communication technologies as Skype or

Facebook. According to Konttila et al. (2018), to use new technologies in nursing care, need support of organisation and collegian.

In this study, the majority of patients over 85 years old had a poor level of physical activity, which may be due to the fear of moving independently. According to Chen et al., (2014), leading causes of declining physical condition in older people include: advanced age, chronic diseases such as osteoporosis, fragility fractures, and obesity or loss of weight. According to Korpelainen (2005), weight-bearing exercise is a safe, feasible, and effective way of mitigating established risk factors for falls and fractures, and may even prevent fall-related fractures in older women. This is also easy to implement in the clinical practise during patients daily activities and nurse may give feedback after exercise. It is known that regular exercise and physical activity involving moderate impact activities for 30-60 minutes two or three times a week (Palombaro, 2013; Simmonds et al., 2016). It also improves muscle mass, strength (Papaioannou et al., 2010) and improves bone mineral density and content (Mosti et al., 2013), which all prevent falls (Fletcher, 2013; Garrison, 2012; Palombaro, 2013; Simmonds et al., 2016; Timmer et al., 2009). Significant decrease in the level of physical performance in daily activities may come as a surprise in older age, which is an important factor patient education with the working age population.

Strengths and limitations

This study was a retrospective study at one University hospital. Therefore, study findings are not transferable to other hospitals and it is difficult to generalize the results. Trained nurse made data collection with the same data collection methods for each participant. The data were collected using of an instrument, which has been previously tested for construct validated and reliability. A limitation is found in that the items were measured by using

dichotomous answer options. Therefore, participants have no opportunity answer "I do not know", for example, when they were asked knowledge of fracture their parents have been. In addition, this study was conducted only in one University hospital and with a limited number of participants and therefore generalisation of the results must be done with caution. It also needs to be borne in mind that most of the participants were female over the age of 65.

Implications for clinical practice

The nurses have a key role in health promotion and health improvement in clinical practice. Clinical practise is important to take account patients lifestyle factors and motivation to make changes their lifestyle. It is possible to improve osteoporosis and fragility fractures patients' quality of life by developing new, patient time saving methods using intervention supported by technology.

Conclusion

The key message in our study is that the risk of osteoporosis and fragility fractures among women increases in higher age and early menopause. There are also association on physical activity and nutrition for risk of fractures. In particular, lifestyle related factors are important predictors for fragility fractures and osteoporosis. We recommend the utilization of preventative treatments in clinical practice, for instance education risk factor for patients already at the working age using technological equipment to support patients' motivation to take part of education.

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511 Table 1. Background information on participants (n=294)

	n	%
Gender		
Female	268	91
Male	26	9
Age (mean 74)		
45-64	69	23
65-84	179	61
85-104	46	16
Body Mass Index (n=254)		
BMI<18	12	5
BMI18.5-25	128	50
BMI 26-30	67	26
BMI>30	47	19
Type of fracture		
wrist	101	22
hip	99	21
ankle	65	14
vertebrae	59	13
shoulder	40	9
tibiae	24	5
lumbar	22	5
elbow	20	4
ribs	10	2.2
thoracic spine	9	2
knee	5	1
scapula	4	0.8
neck	3	0.6
instep	1	0.2
Osteoporosis		
yes	199	68
no	95	32

512

513 Table 2. Participants' responses to lifestyle questions (n=294)

Lifestyle factors	n	%	p*
Diet			
Normal diet	223	76	0.68
Lactose -free diet	49	17	
Gluten-free diet	11	4	
Vegetarian diet	2	1	
Gout milk diet	2	1	
Dairy products			
Use dairy products	209	71	0.02
Non-dairy diet	79	27	
Physical activity			
Poor movement with use of aids, no physical exercise at all	92	31	0.01
Normal movement, no physical exercise at all	91	31	0.04
Normal movement, engages in sports activities	106	36	
Physically inactive and smokes	46	15.9	0.02
Lifestyle			
Smoking	62	21	0.29
Not smoking	228	78	
Smoking and alcohol use			<0.01
Use of alcohol	30	10	0.84
No use of alcohol	260	88	

***p-value in Chi-Square test.**

514

515

Table 3. Statistical measures for potential osteoporosis risk factors (n=294)

Factors relating to osteoporosis	OR	Cl, 95%	p
Female			
Risk	2.97	1.30-6.78	**0.01**
No risk	1		
Early menopause			
Risk	3.87	1.32-11.37	**0.02**
No risk	1		
Basic diet			
Risk	0.98	0.54-1.78	0.95
No risk	1		
Lactose-free diet			
Risk	1.07	0.55-2.08	0.84
No risk	1		
Gluten-free diet			
Risk	0.81	0.23-2.84	0.74
No risk	1		
Use of dairy products			
Risk	0.74	0.41-1.31	0.29
No risk	1		
Physical inactivity			
Risk	2.03	1.11-3.98	**0.02**
No risk	1		
Physical activity			
Risk	1.07	0.57-2.01	0.84
No risk	1		
Smoking			
Risk	0.88	0.46-1.70	0.72
No risk	1		
Smoking and physical inactivity			
Risk	2.03	1.08-3.81	**0.03**
No risk	1		
Smoking and fracture of the shoulder			
Risk	2.53	1.0-5.17	**0.05**
No risk	1		
Alcohol use			
Risk	0.98	0.41-2.37	0.98
No risk	1		

Statistically significant p-value marked in bold