Survey over osteoporosis Patient knowledge, perspectives and practices

Student: Grace Gan Oon Bee, KU Leuven

Promotor: Professor Dr Geert Gooderis

Master of Family Medicine

Masterproef Huisartsgeneeskunde
Academiejaar: [2023 – 2024]

Deze masterproef is een examendocument dat niet werd gecorrigeerd voor eventueel vastgestelde fouten. Zonder voorafgaande schriftelijke toestemming van zowel de promotor(en) als de auteur(s) is overnemen, kopiëren, gebruiken of realiseren van deze uitgave of gedeelten ervan verboden. Voor aanvragen tot of informatie i.v.m. het overnemen en/of gebruik en/of realisatie van gedeelten uit deze publicatie, wendt u tot de universiteit waaraan de auteur is ingeschreven.

Voorafgaande schriftelijke toestemming van de promotor(en) is eveneens vereist voor het aanwenden van de in dit afstudeerwerk beschreven (originele) methoden, producten, schakelingen en programma's voor industrieel of commercieel nut en voor de inzending van deze publicatie ter deelname aan wetenschappelijke prijzen of wedstrijden.

Acknowledgements

First and foremost, I would like to thank my promoter, Prof. Dr Geert Gooderis for his guidance, constructive feedback and time throughout this process.

I would also like to thank the health insurance funds, especially the CM, Helan and Solidaris for helping me in the data collection process.

I would also like to thank my POs, Dr. Wim Van Spaendonck, Dr. Wouter Demerre and Dr. Yves Vloemans for their support and guidance throughout my HAIO journey. I was lucky to train under each of you. Also, a heartfelt thank you to my colleagues in Remedici who have made the last year and a half of my training beautiful.

Finally, I would like to thank my family for making this master thesis possible. My utmost gratitude to my husband, Peter Van Bouwel who looked after our little one to ensure I would be able to see this through. I thank my deceased mother-in-law, Swis for lending me her laptop without which this master thesis would not have been completed. I thank the rest of my extended family for their love and support throughout this process.

Table of Contents

Abstract……5
Abbreviations……6
1 Introduction……7-8
1.1 Background……7
1.2 Objective……8
2-Materials and Method……9-12
2.1 Literature review……9
2.2 Field Study……9
2.3 Research Questions……10
2.4 OKAT tool……10
2.5 Selection and Description of Participants……11
2.6 Recruitment……11
2.7 Statistics……11-12
3- Results of the Literature Review……13-17
3.1 Definition and Epidemiology……13
3.2 Diagnosis……13
3.3 Risk Factors……14-16
3.4 Management……16-17
4 Results of the Study……18-24
5 Discussion……25-28
6 Conclusion……29
7 Appendix……30-37
8 References……38-40

Abstract
Huisarts-in-opleiding: Grace Gan Oon Bee, KU Leuven
Promotor: Prof Dr Geert Gooderis
Praktijkopleider: Dr Wouter Demerre en Dr Yves Vloemans

Context: Osteoporose is een chronische aandoening veroorzaakt door een verstoord evenwicht tussen botaanmaak en botafbraak. Er wordt geschat dat één derde van de vrouwen na de menopauze aan osteoporose lijden, maar toch is de ernst van deze ziekte niet altijd evident voor patiënten. Dit onderzoek heeft als doel om de kennis, houding en praktijk van patiënten met betrekking tot osteoporose te bestuderen.

Methode: De Osteoporose Knowledge Assessment Tool (OKAT), een 20-punten vragenlijst over osteoporose werd gebruikt om kennis over osteoporose te evalueren. Een vragenlijst werd opgesteld bestaande uit demografische vragen, de OKAT-tool en een extra component om de praktijken, overtuigingen en ervaringen van patiënten met betrekking tot botgezondheid in de eerstelijnszorg te bestuderen. Deze vragenlijst werd verdeeld door verschillende ziekenfondsen aan leden, die vrouwen boven 65 zijn, in Vlaanderen.

Resultaten: Voor het onderzoek werden 892 deelnemers gerekruteerd. 62% van de deelnemers toonde voldoende kennis over osteoporose. Een overweldigende meerderheid van de patiënten (72%) besprak osteoporose zelden of nooit met hun huisarts. Meerdere aandoeningen, resulterend in minder aandacht voor osteoporose, en beperkte tijd waren aangeduid als de belangrijkste uitdagingen. Van de 165 patiënten die antiresorptieve therapie kregen, meldde 79% dat ze dagelijks een calcium-en vitamine D-supplement gebruikten.

Conclusie: Deze studie heeft specifieke aspecten van osteoporose geïdentificeerd waar er een tekort in patiëntkennis is. De patiënttevredenheid over de communicatie over de botgezondheid in de eerstelijnszorg is laag. Onze bevindingen suggereren dat betere preventieve maatregelen in de huisartspraktijk moeten worden geïntegreerd om het bewustzijn over osteoporose te vergroten.

E-mail: graceganoonbee@gmail.com

Abbreviations

Osteoporosis Knowledge Assessment Tool……OKAT
Bone Mineral Density……..BMD
Dual energy X-ray Absorptiometry-technique……DXA
Selective Estrogen Receptor Modulators……SERM
International Units……IU

1 Introduction

1.1 Background

Osteoporosis is a significant health issue causing up to 37 million fractures annually worldwide[i]. This disease is not only associated with a significant economic burden but also substantial loss of quality of life, disability and increased mortality. Patients with osteoporosis suffer a reduction in bone mass due to an imbalance of bone resorption and formation[ii]. Deterioration of bone tissue on a micro architectural level occurs, thereby increasing the risks of fragility fractures[iii]. Currently, this risk is estimated at 1 in 3 in post-menopausal women and 1 in 5 for men above 50 in Belgium[iv]. As the risk of primary osteoporosis increases with age and menopause, osteoporosis is much more prevalent in women compared to men (32.28/1000 women vs 5.33/1000 men in Belgium in 2021)[v]. Secondary osteoporosis, however, can be caused by other comorbidities or through iatrogenic interventions.

Despite the huge burden of disease, it is unclear if patients have a strong understanding of osteoporosis. Thus, it is imperative to identify the areas where patient knowledge gaps are the greatest to be able to provide targeted and specific advice to patients. Furthermore, it is crucial to study the attitudes, beliefs, and experiences of patients regarding osteoporosis and bone health in primary care. General practitioners play a vital role in preventive medicine by being the first and most frequent point of contact with patients. Understanding the barriers to the management of bone health from a patient perspective is thus important in devising strategies to ensure good education and communication in the first line.

1.2 Objective

This study had three main objectives. The main aim of the study was to evaluate the knowledge level of patients over osteoporosis with a valid and reliable instrument. Our second goal was to study patient attitudes and experiences regarding osteoporosis. This encompasses patient views on the quality of communication and education over osteoporosis, fall prevention and available treatment options. As part of this objective, we also aimed to identify the biggest barriers to effective management of osteoporosis from the perspective of the patient. The third objective was to study the adherence to calcium and vitamin D therapy amongst patients with osteoporosis. According to the Belgian Bone Club 2020 guidelines for the management of osteoporosis, supplementation with 800-1000IU of vitamin D daily is recommended for patients receiving pharmacologic therapy for osteoporosis[vi]. A daily dietary calcium intake of 1200mg was also recommended. We wished to investigate the compliance of patients with osteoporosis with these recommendations. Based on the findings from our study, we intended to evaluate the areas of knowledge gaps in patients and identify the main barriers to management of osteoporosis thereby raising awareness about these areas among general practitioners.

2 Materials and Methods

2.1 Literature Review

A literature review was conducted using the waterfall model. The search method began with reading quaternary sources, including current guidelines on osteoporosis and fall management. These included NHG standaard "Fractuurpreventie" from 2012, 'Praktijkinstrumentan Val- en Fractuurpreventie" developed in 2015 by Domus Medica together with the Expertise Center for Fall and Fracture Prevention Flanders, "The Belgian Bone Club 2020 Guidelines for the Management of Osteoporosis in Post-Menopauzal Women" and "Osteoporosis: Assessing the Risk of Fragility Fracture" first published in 2012 by the National Institute for Health and Care Excellence (updated in 2017).

Tertiary sources included the journal Minerva (Evidence-Based Medicine for the first line) and the Belgian national formulary (Belgisch Centrum Voor Farmacotherapeutisch Informatie).

Furthermore, our study required us to search for a suitable tool to evaluate the knowledge level of osteoporosis. An extensive search on PubMed using the following MESH terms and keywords was conducted: Survey osteoporosis, patient knowledge osteoporosis, attitudes osteoporosis, practice osteoporosis. From our research we found the OKAT tool to be a reliable and validated instrument to measure osteoporosis knowledge. Primary sources included information attained from the Belgian Bone Cub Clinical Update Symposium in 2024.

2.2 Field Study

A cross-sectional quantitative study was conducted via an online questionnaire. To ensure the questions were as representative as possible, based on scientifically validated methods, the preparation of the study was preceded by a thorough literature study and consultation of a manual for drawing up questionnaires. Other studies using surveys as a research method were also consulted as examples. The questionnaire was created using a web platform KU Leuven Qualtrics and was accessible to respondents via an online link.

The questions had different response modalities, such as short free text fields, multiple choice answers (options, check boxes), linear scale (disagree, neutral, and agree), yes/no, and true/false outcomes.

2.3 Research Questions

Our main research questions were:

- How comprehensive is patients' knowledge about the risk factors of osteoporosis?
- How comprehensive is patients' knowledge about osteoporosis prevention?
- How comprehensive is patients' knowledge about treatment for osteoporosis?
- How comprehensive is patients' knowledge about the consequences of osteoporosis?
- How do patients experience communication about bone health in primary care?
- What are the barriers to good care for osteoporosis in primary care from a patient's perspective?
- How is adherence to supplements among patients with osteoporosis?

2.4 OKAT tool

To answer these questions, we took the OKAT questionnaire as a starting point and made the necessary adjustments for the Belgian healthcare context. The OKAT is a 20-point instrument with true, false and don't know responses. It was drafted by Winzenberg et al in 2003 based on the Osteoporosis Australia Osteoporosis Prevention and Self-management course and the information leaflet "Understanding Osteoporosis"[vii]. This tool had also been used in other studies in Saudi Arabia and in Hungary where it was concluded that the tool was both objective and reliable[viii]-[ix].

After translation into Dutch, a native Dutch speaker tested the questionnaire. They did not report any issues regarding readability and clarity. Questions answered correctly received 1 point and questions answered incorrectly or as 'don't know' received 0 points. The total point range was 0-20. The following cut-off points were used: very poor (less than 5), poor (6-8), average (9-12), good (13-16) and very good (17).

2.5 Selection and description of participants

Our target population comprised of women aged 65 and above in Flanders who are fluent in Dutch and affiliated with health insurance funds. Women with a place of residence outside Flanders or who did not give informed consent at the beginning of the questionnaire were excluded.

2.6 Recruitment

We created a questionnaire using a web platform KU Leuven Qualtrics consisting of demographic questions, the OKAT tool and an additional component to study patient practices, beliefs and experience regarding bone health in primary care.

Accordingly, we reached out to women across Flanders via their health insurers. The health insurance funds who agreed to work with us on this project were the Christelijke Mutualiteit, Helan and Solidaris. As the survey was publicly published in newsletters, websites and Facebook pages of the health funds, we also received several participants from other health funds.

2.7 Statistics

Data was collected in a Microsoft Excel spreadsheet. This spreadsheet was processed using a Python application that utilizes Pandas for processing the data. The data was organized in an overview to enable the evaluation of scores based on demographic categories (age, province, migration status, education level, occupation and health fund insurance). The respondents were also grouped into different categories based on their OKAT scores: very poor, poor, average, good and very good. Furthermore, measures of correlation between OKAT scores and each of the demographic categories listed above were conducted using chi-squared tests.

Each OKAT question was also evaluated individually. Percentages and number of respondents who answered correctly, wrongly, and who did not know the answer were analysed to determine the knowledge level regarding specific aspects of osteoporosis.

Data on attitudes, beliefs, and experiences of patients were organized and presented using graphs, namely the frequency of discussion over osteoporosis in primary care from a patient perspective and the percentage of patients

taking vitamin D and calcium supplements. Additionally, data on patient satisfaction over communication about osteoporosis, treatment, dietary requirements, physical activity and falls were summarized in a table. The diverse barriers to providing good bone health care in primary practice were evaluated and presented in a diagram.

3 Results of the Literature Review

3.1 Definition and Epidemiology

Osteoporosis is a chronic disease characterized by a mismatch in bone resorption and formation, leading to a reduction in bone mineral density (BMD), and bone mass and consequently increase in fracture risk[x]. The disease is progressive and is often asymptomatic until the occurrence of the first fracture. Common fractures associated with osteoporosis include hip, spine and wrist fractures[xi].

According to INTEGO, a Flemish General Practice Registration Network for the monitoring of diseases, the prevalence of osteoporosis in Flanders in 2021 was 346 810 cases [v]. The yearly incidence of osteoporosis was reported as 646, which is a drastic increase from 278 cases in 2011 [v]. Certainly, the burden of disease on the Belgian healthcare system is significant with over 600 million euro spent on treating complications of osteoporosis [xii]. Furthermore, transitions to nursing homes were required in one in five elderly patients post-fracture, meaning that the indirect costs from osteoporosis are higher than reported [xii].

3.2 Diagnosis

The gold standard to diagnose osteoporosis is a Dual energy X-ray Absorptiometry-technique (DXA) scan [xiii]. A T-score less than or equivalent to –2.5 confirms a diagnosis of osteoporosis. A T-score between –1 to –2.5 indicates osteopenia whereas a score above or equivalent to –1 is normal. The limitation of this test is that BMD can be falsely high in conditions such as lumbar osteoarthritis and aortic calcification. Nonetheless, Domus Medica does not recommend systematic referrals for DXA scans in patients with increased fall risk. Instead, screening with DEXA is recommended based on other factors such as age and previous fractures.

A useful tool to evaluate the 10-year probability of fractures is the FRAX-tool [xiv]. This instrument was developed by the University of Sheffield based on studies of population cohorts in Europe, Asia, North America and Australia. The tool considers various factors such as age, sex weight, height, previous fracture, family history, smoking, glucocorticoid usage, rheumatoid arthritis, secondary osteoporosis, alcohol and BMD. Based on these factors, scores for the risk of major osteoporotic fractures and hip fractures are generated

which can be useful in deciding the threshold for pharmacologic intervention.

3.3 Risk Factors

There are multiple risk factors for osteoporosis that can be classified as non-modifiable or modifiable and secondary causes of osteoporosis.

Non-modifiable:

-Age: Age has been identified as an independent risk factor for osteoporosis regardless of BMI [xv].

-Gender: Estrogen plays a significant role in regulating bone turnover. There is a simultaneous increase in osteoclastic resorption and decrease in osteoblastic formation of new bone leading to loss of BMD post menopause. During the menopausal transition period alone, there is an average reduction of BMD by 10% [xvi].

-Ethnicity: The Caucasian race is a risk factor for osteoporosis. Elderly Asian men and women were found to have a lower fracture risk than their counterparts with the Caucasian race. Furthermore, African American women were found to have a higher BMD than Caucasian women at every level of body weight which diminishes their fracture rate [xvii].

-Prior fractures: The risk of subsequent clinical fractures is increased in all locations after the first fracture. A retrospective cohort study of 377 561 respondents showed that women over 65 with a clinical hip fracture were at 8%, 15% and 25% risk of a subsequent fracture at 1, 2 and 5 years respectively. 10% of subsequent clinical fractures occurred within 1 year, 18% within 2 years and 31% between 5 years post initial fracture [xviii].

-History of falls: One in three adults over the age of 65 experience a fall each year with 10% experiencing serious injury such as fractures. Post fall, a fear of subsequent fall may lead to reduction in physical activity and decrease in exercise. Unfortunately, this causes a reduction in muscle strength and self-efficacy which in turn further increases the risk of falling [xix].

-Family history: Diverse gene polymorphisms in vitamin-D, estrogen, parathyroid hormone, calcium receptors etc. have been related to variations

in BMD. Furthermore, a 2004 meta-analysis of parental history of fracture and fracture risk showed a significantly increased risk of any fracture, osteoporotic fracture and hip fracture in both genders regardless of BMD [xx].

-Reproductive factors: Early menopause is a risk factor for osteoporosis due to estrogen deficiency. An early menopause (before 50 years old) was associated with a higher overall fracture rate that remained observable even after substantial periods of time [xxi].

Modifiable:

-Nutritional factors: The most important nutrients for bone health are calcium, vitamin D and protein [xxii]. A deficiency of these nutrients is a cause of premature bone loss and osteoporosis. Likewise, overconsumption of certain nutrients such as protein and sodium chloride (salt) are also harmful to bone health due to increased urinary calcium excretion [xxiii]. This can provoke bone resorption to restore calcium levels, which in turn increases the risk of osteoporosis.

-Lack of physical activity/falls risk: Falls are a major risk factor for clinical fractures in the elderly. Inactivity and reduced neuromuscular function have been shown to increase the risk of falls. Women who sat for at least 9 hours a day were shown to have a 43% higher risk of hip fractures than women who sat for less than 6 hours a day [xxiv].

-Cigarette smoking: Smoking has been shown to increase the risk of osteoporosis via diverse pathways. Firstly, due to variations in parathyroid metabolism, smokers have been shown to have a decrease of circulating levels of 1,25-dihydroxyvitamin D [xxv]. Smoking also causes a rise in follicle stimulating hormone and luteinizing hormone which reduce estrogen levels and promote bone loss [xxvi].

-Alcohol consumption: Decreased BMD, increased falls risk and increased risk of fractures have been reported in chronic alcohol consumers. Several reports show that women who consumed greater than 25g of alcohol per day to have a higher risk of both hip and wrist fractures [xxvii].

-BMI: A low BMI is associated with low BMD, muscle weakness and increased bone loss in post-menopausal women [xxviii].

Secondary causes:

Various comorbidities and medications have been shown to increase the risk of osteoporosis [xxix]. Other diseases increase the risk of falls and thus by default fractures [xxx].

Co-morbidity	Hypogonadsim
	Hyperparathyroidism
	Chronic liver disease
	Inflammatory disease such as rheumatoid arthritis
	Vitamin D deficiency
	Renal disease
	Cardiovascular disease
	Diabetes mellitus
	Dementia
	Sight impairment
	Orthostatic hypotension
Medication	Systemic glucocorticoids
	Proton pump inhibitors
	Selective serotonin receptor inhibitors
	Thiazolidinediones
	Anticonvulsants
	Medroxyprogesterone acetate
	Aromatase inhibitors
	Androgen deprivation therapy
	Calcineurin inhibitors
	Heparin
	Certain chemotherapies

3.4 Management

Non-pharmacologic: The non-pharmacologic management of osteoporosis is focused on physical activity, a healthy diet and falls prevention. Weight bearing exercises such as aerobic exercise and resistance training have been shown to have favourable effects in BMD in post-menopausal women [xxxi]. Ideally physical activity should be optimized from long before menopause as a 10% increase in peak bone mass may delay the development of

osteoporosis by 13 years as well as reduce the risk of post-menopausal fragility fractures by half [xxxii].

Secondly, adequate calcium, vitamin D and protein intake is important in osteoporosis treatment as described above. Thirdly, fall prevention is a cornerstone of bone health. This includes measures such as ensuring adequate lighting, clear and wide access to spaces around the house, removal of obstacles in common areas and from stairs, using anti-slip mats in the bathroom etc [xxxiii].

Pharmacologic: The pharmacologic treatment of osteoporosis rests on two main aims, namely anabolic therapy and anti-resorptive therapy [xvii]. Anabolic therapy aims to stimulate bone synthesis and thus increase bone mass. Drug classes in this category include recombinant hormones, calcium supplements and calcimimetics. In recent years, a new humanized monoclonal antibody, Romosozumab has been shown to promote bone formation and reduce bone resorption when administered subcutaneously over 12 months [xxxiv]. Romosozumab was also shown to be superior to placebo, alendronate and subcutaneous teriparatide in increment of BMD at 12 months with these benefits maintained at 12-24 months after transitioning to anti-resorptive therapy.

Anti-resorptive therapy is aimed at strengthening bone and reducing bone turnover [xvii]. Drug classes include bisphosphonates, hormone replacement therapy, selective estrogen receptor modulators (SERM) and anti-RANKL antibodies (denosumab). Bisphosphonates are the most widely used drugs in this category and while highly effective, they have been associated with adverse effects such as gastro-intestinal inflammatory disorders, infusion reactions, hypocalcemia, arthralgia, myalgia. In rare cases, atypical femoral fractures and osteonecrosis of the jaw can occur. Oral bisphosphonates should be consumed more than 30 minutes before the first food or medication intake. Post intake, patients should be instructed to stay upright for at least 30 minutes to avoid esophageal irritation and ulceration[xxxv].

4 Results of the Study

892 participants were recruited for the study. Most participants were between 65-74 years of age, retired and of Belgian nationality. The participants were spread across the Flemish provinces. 64.79% were in possession of a higher school diploma or higher.

Table 1 Sociodemographic properties of the participants

Demographic category		n	percentage
Age category	65-74	755	84.64
	75-84	134	15.02
	85-94	3	0.34
Province	West Flanders	136	15.25
	Flemisch Brabant	221	24.78
	East Flanders	146	16.37
	Antwerp	246	27.58
	Limburg	143	16.03
Migration status	Belgian	861	96.52
	Western migration background - Western Europe, United States, Australia and New Zealand	25	2.80
	Non-Western migration background - Asia, Eastern Europe, Africa, Latin America	1	0.11
	Other	5	0.56
Education level	Candidate/PhD	7	0.78
	Masters degree	143	16.03
	Bachelor degree	110	12.33
	Higher school diploma or equivalent	318	35.65
	Secondary school diploma or equivalent	260	29.15
	Primary school diploma or lower	54	6.05
Profession	Retired	872	97.76
	Employed	9	1.01
	Independent	8	0.90
	Chronic invalidity	2	0.22

	Government servant	1	0.11
Health insurance fund	Helan	72	8.07
	Cm	784	87.89
	Other	8	0.90
	Solidaris	28	3.14

62.1% of participants displayed an adequate knowledge of osteoporosis by attaining average to very good scores. The calculated median score was 9, namely at the lower range of average. 13.46% attained good or very good scores while 37.90% of respondents failed the test.

Table 2 Scoring categories from the OKAT survey

Score category	n	%
Very poor (less than 5)	36	4.04
Poor (6-8)	302	33.86
Average (9-12)	434	48.65
Good (13-16)	117	13.12
Very good (17)	3	0.34

There were no statistically significant differences in score identified within demographic properties (p score > 0,05).

Table 3 Correlations between score per demographic category

Category	P-score
Age category	0.42
Province	0.71
Migration Status	0.75
Education Level	0.63
Profession	0.20
Health Education Fund	0.71

From the OKAT questionnaire, over 90% of patients knew that osteoporosis led to an increased risk of fractures and that the disease was more prevalent among women. A little more than half of respondents (56.50%) were aware that osteoporosis was commonly asymptomatic before the first fracture. 40.02% of respondents were aware that a higher bone mass at the end of childhood was protective against osteoporosis at a later age. 65.02% correctly identified smoking and 63.79% correctly identified family history as risk factors for osteoporosis. Additionally, more than 50% of respondents

were aware that the risk of osteoporosis increased with age although only 30.27% believed that most women above 50 would experience at least one fracture in their lifetime. 39.46% of respondents correctly answered that a moderate intake of alcohol had little effect on osteoporosis. Strikingly only 28.48% correctly identified the Caucasian race as a risk factor while only a dismal 14,80% of respondents knew that a high salt intake was a risk factor for osteoporosis. With regards to fall prevention, 62.44% of respondents were aware that a fall is as important as low bone density in causing fractures.

An overwhelming majority of respondents, 95.96%, believed that there is a small amount of bone loss in the 10 years following menopause. This is incorrect seeing that there is a significant reduction in both cortical and trabecular bone in this period. Only a little more than a third of respondents (37.33%) believed that it was easy to evaluate their risk for osteoporosis based on their clinical risk factors. Another common misconception (80.83% wrong) is that every form of physical activity is beneficial for osteoporosis. This is untrue as certain physical activity such as walking alone has not been found to increase bone mass [xxxi]. With regards to dietary questions, 62.56% of respondents correctly identified broccoli and sardines as good sources of calcium for those who cannot tolerate mild products. 68.72% of participants were aware that calcium supplementation was not the only way to achieve the daily calcium requirement.

Surprisingly 70.63% of women either did not know or answered incorrectly about the ability of hormone therapy to prevent bone loss at every age after menopause. Nearly half of respondents (49.44%) were also unsure or answered mistakenly that there were no effective treatments for osteoporosis in Belgium.

Table 4 OKAT scores per question

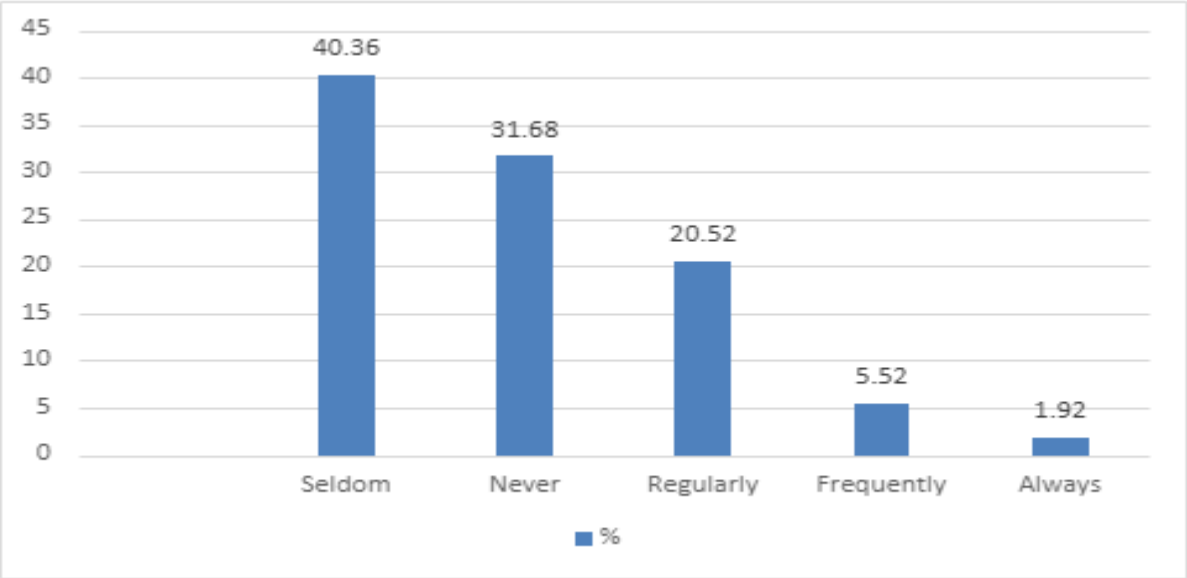
OKAT Question	N Correct	% Correct	N Wrong	% Wrong	N I don't know	% I don't know
Osteoporosis leads to an increased risk in bone fractures	883	98.99	2	0.22	7	0.78
Osteoporosis usually causes symptoms e.g. pain before fractures occur	504	56.50	187	20.96	201	22.53

Having a higher peak bone mass at the end of childhood gives no protection against the development of osteoporosis in later life	357	40.02	153	17.15	382	42.83
Osteoporose is more common in men	809	90.70	7	0.78	76	8.52
Cigarette smoking can contribute to osteoporosis	580	65.02	57	6.39	255	28.59
White women are at highest risk of fracture as compared to other races	254	28.48	125	14.01	513	57.51
A fall is just as important as low bone strength in causing fractures	557	62.44	194	21.75	141	15.81
By age 80, the majority of women have osteoporosis	474	53.14	175	19.62	243	27.24
From age 50, most women can expect at least one fracture before they die	270	30.27	258	28.92	364	40.81
Any type of physical activity is beneficial for osteoporosis	105	11.77	721	80.83	66	7.40
It is easy to tell whether I am at risk for osteoporosis by my clinical risk factors	333	37.33	191	21.41	368	41.26
Family history of osteoporosis strongly predisposes a person to osteoporosis	569	63.79	105	11.77	218	24.44
An adequate calcium intake can be achieved from two glasses of milk a day	271	30.38	356	39.91	265	29.71
Sardines and broccoli are good sources of calcium for people who cannot take dairy products	558	62.56	51	5.72	283	31.73
Calcium supplements alone can prevent bone loss	613	68.72	122	13.68	157	17.60
Alcohol in moderation has little effect on osteoporosis	352	39.46	254	28.48	286	32.06
A high salt intake is a risk factor	132	14.80	244	27.35	516	57.85

for osteoporosis						
There is a small amount of bone loss in the ten years following the onset of menopause	36	4.04	732	82.06	124	13.90
Hormone therapy prevents further bone loss at any age after menopause	262	29.37	240	26.91	390	43.72
There are no effective treatments for osteoporosis available in Belgium.	451	50.56	140	15.70	301	33.74

In the third part of the survey, patient experiences regarding osteoporosis in primary care were explored. An overwhelming majority of patients (72.04%) seldom or never discussed osteoporosis with their general practitioner although 80.27% considered osteoporosis to be an important health problem.

Figure 1 Frequency of Discussions over Osteoporosis in General Practice According to Patients



Overall patient satisfaction over the information and explanations received from the general practitioner over different aspects of osteoporosis was also investigated. Most patients took a neutral standpoint over information received over osteoporosis, treatment options and fall prevention. A more prominent group of patients (43.18%) reported feeling that the dietary advice around osteoporosis was insufficient. Oddly, 46.90% of patients felt that they had received good advice around physical activity and osteoporosis

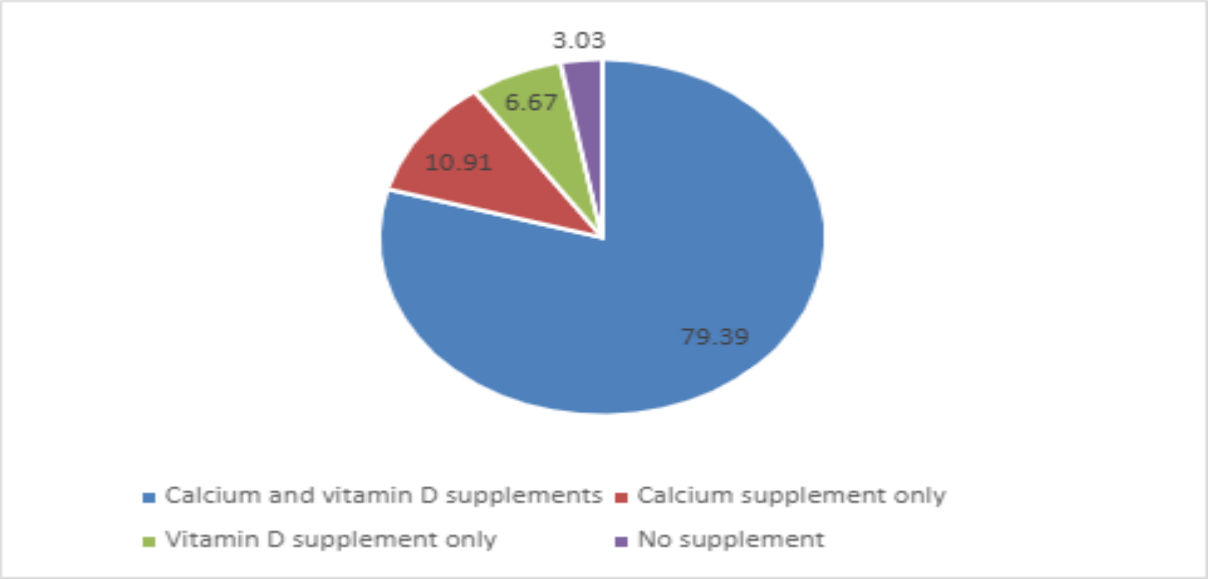
although only 11.77% of patients answered correctly that not all types of exercise were beneficial for osteoporosis.

Table 4 Patient Experience over Information over Osteoporosis from General Practitioners

I have received a good explanation about:	Agree		Neutral		Disagree	
	N	%	N	%	N	%
Osteoporosis	250	28.18	404	45.55	233	26.27
Treatment of osteoporosis (aims, adverse effects, method of using medication)	206	23.25	448	50.56	232	26.19
Dietary advise with respect to osteoporosis	98	11.05	406	45.77	383	43.18
Physical activity with respect to osteoporosis	416	46.90	288	32.47	183	20.63
Fall prevention	296	33.41	355	40.07	235	26.52

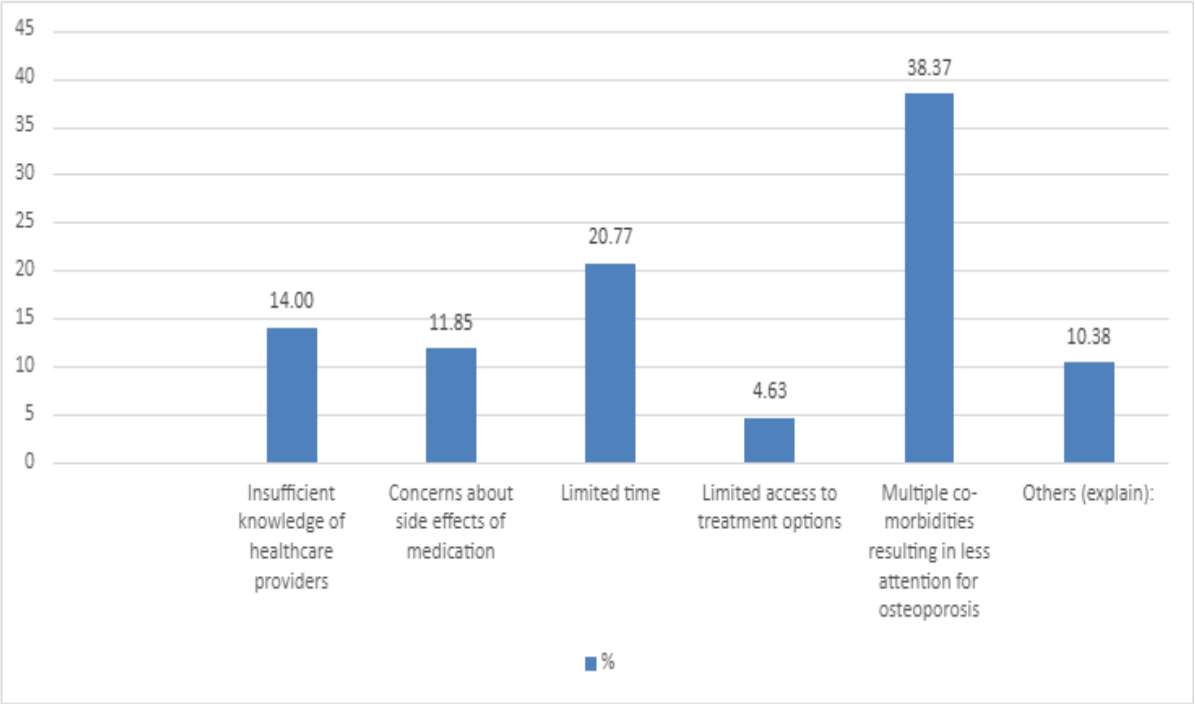
Moreover, 165 respondents reported to be under therapy for osteoporosis such as prolia, fosamax and alendronate. 79.39% of these respondents disclosed that they consumed a calcium and vitamin D supplement daily. 10.91% consumed only a calcium supplement whereas 6.67% of patients only took vitamin D daily. A minority of 3.03% were on neither calcium nor vitamin D supplementation.

Figure 2 Calcium and Vitamin D Supplementation in Women with Osteoporosis



The final part of the survey studied the biggest barriers to the management of osteoporosis from a patient perspective. Multiple co-morbidities resulting in less attention for osteoporosis and limited time during consultations were identified as the main challenges by respondents. Other reasons raised were too much focus on medication and supplements as opposed to physical activity, lack of initiative from general practitioners to address osteoporosis and a delayed response by general practitioners to request a DEXA scan.

Figure 3 Diverse Barriers to Management of Osteoporosis from a Patient Perspective



5 Discussion

Our study revealed a high interest in osteoporosis among post-menopausal women in Flanders. The high number of respondents suggests that osteoporosis is viewed as an important health issue in this patient population and that they are eager to share their experiences to contribute to better bone health care. Most respondents (62%) displayed an adequate knowledge of osteoporosis by attaining average to very good scores. However, this still meant that more than one-third failed the test for osteoporosis. Moreover, the median score was 9, which is the minimum score required to pass the test. This is similar to a study utilizing the OKAT tool in Australia, where the median score was 8.8[vii]. Next, in our study, only 3 respondents displayed a very good knowledge of osteoporosis, which is dismal. This is comparable to the results of a similar study in Saudi Arabia evaluating the knowledge of osteoporosis in pre-menopausal women. In that study, 55% of participants passed the assessment but only 1.4% had a good level of knowledge [viii]. In general, the results of the Belgian population are similar to Australia and Saudi Arabia, in that the majority of participants pass the test with low-average scores but very few had an exceptional score.

Analysis per question showed that over 90% of respondents knew that osteoporosis led to an increased risk of fractures. Commonly correctly identified risk factors were the female sex (90% correct), smoking (65% correct) and family history (64% correct). Knowledge of dietary options and calcium supplementation appears to be adequate. The biggest knowledge gaps in risk factors were a high salt intake and having the Caucasian race with a 15% and 28% correct response rate respectively. Furthermore, participants appear to underestimate the burden of disease as only 30% were aware that most women over 50 could expect at least one fracture in their lifetime. Almost everyone (96%) believed that there is a small amount of bone loss in the 10 years following menopause which is incorrect as a huge decline in BMD occurs in this period. These are thus the key points that general practitioners may focus on when giving education about bone health.

Next, only 37% of respondents believed that it was easy to evaluate their risk for osteoporosis based on their clinical risk factors. This is surprising as there are several tools for this purpose. The International Osteoporosis Foundation offers a free 1-minute screening tool for general practitioners and the population to calculate their risk for osteoporosis [xxxvi]. The FRAX tool is also a

well-known instrument to calculate the 10-year probability of a fracture as discussed above.

Another common misconception with a response rate of 81% wrong answers is that every form of physical activity is beneficial for osteoporosis. This is untrue as certain physical activities such as walking alone have not been found to increase bone mass [xxxi]. Benedetti et al (2018) found weight-bearing aerobic exercises such as Tai Chi, stair climbing, and jogging as well as strength and resistance exercises (lifting weight, swimming, cycling) to be beneficial in increasing bone mineral density in osteoporotic patients. Training with whole body vibration was found to enhance muscle strength but results on bone mineral density were unclear.

There also appears to be a significant knowledge gap over the ability to treat osteoporosis in Belgium. 71% of women either answered incorrectly or did not know that hormone therapy is beneficial for BMD for post-menopausal women regardless of age. Besides hormone therapy, there are also various other effective treatment options as elaborated in our literature study, contradictory to nearly half (49%) of the respondents' beliefs. General practitioners should thus actively question patient beliefs on the treatment of osteoporosis and emphasize that there are good results to be achieved with anabolic and anti-resorptive agents.

Based on the third part of the survey, we can conclude that osteoporosis is a condition that rarely or never receives attention during most consultations. Patient satisfaction over explanations around osteoporosis and its treatment, dietary requirements and fall prevention was at best mediocre. Multiple co-morbidities and limited time during consultations were unfortunately identified as the two biggest barriers to good care for bone health in primary practice. Another interesting point is the frequency of referrals for a DEXA scan. Most patients had the impression that they were referred too late for a DEXA scan, some stating that referral only occurred after a first fracture. This represents an important point that should be included in primary prevention.

With regards to supplementation, there is no information on the dietary habits of women above 65 in Flanders but a study by the Nutrition Information Center of Flanders estimated that 56% of Belgians do not consume the recommended amount of dietary calcium [xxxvii]. This indicates that calcium and vitamin D supplementation in post-menopausal women

may be beneficial, certainly if they do not meet their daily requirements. Most respondents (79%) receiving therapy for osteoporosis consume both vitamin D and calcium supplements. Certainly, this number could be higher should the general practitioner routinely discuss and prescribe supplements to patients with osteoporosis.

The strength of this study is the high number of respondents from different demographic populations who participated in it. We received 892 completed responses in total which is a strong sample size for a descriptive study focusing on women over 65 in Flanders. Furthermore, we opted for an established questionnaire that has been tested in other studies, allowing comparisons to be made with other populations.

Our study had some limitations, namely the online survey method. The chosen method entailed that participants would have to have access to a computer and be able to follow the link to the survey. This meant less representation for the age category 85-94 years old, seeing that we only received 3 responses. Furthermore, there was no time limit on the survey or checks that no external resources were used during the test. This may explain why there was no correlation found between scores and education level. Lastly, the OKAT Tool was translated to Dutch by the researchers, but the translated version was not tested on a wide scale for Flesch Reading Ease.

In summary, specific points of interest when giving education about risk factors of osteoporosis should include race and high salt intake. General practitioners should also emphasize the significant loss of bone mass post menopause and use validated instruments to evaluate fracture risk such as the FRAX tools. This information should be shared with patients to give them a concrete idea of their risks for the future and serve as a starting point for discussing treatment options. Next, general practitioners should advise physical activity and be specific in the exercises that contribute to BMD
Medication including HRT should be discussed with the emphasis that there are good treatment modalities available in Belgium. From our study, these are the biggest areas of knowledge gaps that should be addressed in education on bone health.

As limited consultation time and the presence of multiple comorbidities taking attention away from bone health appear to be the biggest barriers, further research should be done into the incorporation of reading material

such as brochures during consultations. This would allow patients to learn more about osteoporosis in their own time and space. Future research is recommended to build on this study's findings. For example, quantitative analysis re-evaluating knowledge levels and satisfaction over communication post provision of modified advice and incorporation of reading materials. We also recommend practice improvement projects such as exercise programs and regular consultation of the guidelines with regards to referral for DEXA and maximization of osteoporosis therapy.

6 Conclusion

This study has shown that there is an interest in osteoporosis among post-menopausal women in Flanders. This is encouraging as that is also the group at highest risk for the disease and who would benefit the most from prevention. Knowledge over osteoporosis was average among the study population. We also identified specific areas of knowledge gaps that general practitioners should keep in mind when discussing osteoporosis. Furthermore, we are now aware that lack of time during consultations and the presence of multiple comorbidities are the foremost reasons why patient satisfaction over bone health communication in primary care is low. Our findings suggest that better preventive measures need to be put in place in general practice to raise awareness over osteoporosis which will ultimately reduce the burden on healthcare systems in the future. This includes practice improvement projects such as exercise programs, using reading materials systematically and regular consultation of the current osteoporosis guidelines.

Appendix:

1. Approval of the Ethics Committee
2. Survey in Dutch with correct answers at the end

Our reference: MP022462
Your reference: Master's thesis study: Survey over osteoporose: patiënten kennis, houding en praktijk
Leuven, 02-12-2022

DEFINITIVE FAVOURABLE ADVICE

Dear Professor Geert Goderis
Dear XXX Grace Gan Oon Bee

The Research Ethics Committee UZ/KU Leuven hereby grants favourable advice to the proposed study, as it was described in the protocol. The Commission is of the opinion that from an ethical standpoint there are no objections to the proposed study. The study was approved on 02-12-2022

Deze studie zal na een literatuuronderzoek een enquête bij vrouwen boven 65 jaar, via Qualtrics, versturen die peilt naar de kennis over osteoporose en gebruik van Ca en Vit D supplementen. Gepland sample is 384 vrouwen uit een populatie > 700000. De uitnodiging en vragenlijst worden via het ziekenfonds van de deelnemers, per e-mail opgestuurd. De bedoeling is van deze vragenlijsten later anoniem te verwerken. Goede data opslag en handling. Er wordt een ICF afgenomen, deze worden ondertekend door de patient aan te laten duiden in Qualtrics dat deze akkoord is met de afname van het onderzoek. Zo blijft de respondent anoniem. Dit is in orde, er zijn geen bezwaren tegen de studie.

Given that the study takes the form of a Master's thesis within the Group Biomedical Science, the application to the Research Ethics Committee UZ/KU Leuven was submitted to the Educational-Support Committee.

The Committee has no objection to the project on the basis of confidential treatment of the data and compliance with the Belgian legislation concerning privacy. The Research Ethics Committee UZ/KU Leuven wishes for the head researcher / promoter of the study to be aware of their responsibilities with regard to the privacy of personal / patient details, when in contact with living persons, patients, and / or contained within electronic medical records, including the correct implementation by employees and students.

This favorable advice concerns the submission of 30-11-2022 and is given for the duration of the Master's thesis of the student(s) concerned. Any amendment to the protocol will invalidate this favorable advice. In that case, you must submit an amendment for advice to the committee that previously approved your file.

The Committee confirms that they work in accordance with the ICH-GCP principles (International Conference on Harmonisation Guidelines on Good Clinical Practice), with the most recent verison of the Helsinki Declaration, and with applicable laws and regulations.

The Committee confirms that in case of a conflict of interest, the members concerned have not participated in decision regarding the study.

Kind regards,

Prof. dr. Minne Casteels
President / Chairperson

Research Ethics Committee UZ/KU Leuven

Prof. dr. Pascal Borry
President / Chairperson
Education-Support Committee for Medical Ethics KU Leuven

Points of Interests (if applicable)

The Research Ethics Committee UZ/KU Leuven wishes for the head researcher / promoter of the study to be aware of their responsiblities with regard to the privacy of personal / patient details, when in contact with living persons, patients, and / or contained within electronic medical records, including the correct implementation by employees and students. The Ethics Committee refers to the guidelines of the ICH/GCP here on the website, and emphasises that GCP-training is expected from every head-researcher for studies that come under the Law on Medical Experimentation. The Ethics Committee refers at the same time to the Belgian legislation (Law from 8/12/1992 for the protection of personal privacy and Law from 22/8/2002 regarding the rights of the patient), and the General Data Protection Regulation (which comes into effect on May 25th 2018).

For use of electronic medical data, a formal agreement from the clinical board is required. The study promotor is responsible for the conformity of foreign language documents with the Dutch language version.

In vitro research on embryos comes under the Law of 11 May 2003. For such research, besides positive approval from the Ethics Committee, approval by the Federal Committee for Medical and Scientific Research on Embryos In Vitro is also necessary before a project can commence.

Before you may commence animal experimentation, approval is required from the Animal Ethics Committee. You must register with this committee for the animal testing component and follow their advice. Please note that you may start the investigation only after you have obtained a definitive favorable opinion from this committee.

Research on human cadavers requires approval of the Care and Support Ethics Committee. You must therefore register with this committee and follow their advice. Please note that you may start the investigation only after you have obtained a definitive favorable opinion from this committee.

This favorable opinion from the Commission does not mean that it takes responsibility for the planned study. You remain responsible for this yourself. In addition, as the principal investigator, you must ensure that the results of this research are correctly displayed in publications, reports for the government, etc.

You are reminded that any serious complication you observe must be reported immediately to both the study promotor (if applicable, the producer) and the Ethics Committee, even if the causal link with the study is unclear.

Demografische gegevens

1. Wat is uw geslacht?
    A. Man
    B. Vrouw
    C. Anders

2.In welke leeftijdscategorie valt u?
    A. 65-74
    B. 75-84
    C. 85-94
    D. 94 en boven

3. In welke provincie woont u?
    A. West-Vlaanderen
    B. Oost-Vlaanderen
    C. Antwerpen
    D. Limburg
    E. Vlaams-Brabant
    F. Brussel
    G. Waals-Brabant
    H. Henegouwen
    I. Namen
    J. Luik
    K. Luxemburg

4. Wat is uw achtergrond? Hebt u een Belgische of een migratieachtergrond? En zo ja, hebt u dan een westerse of niet-westerse migratieachtergrond?
    A. Belgische achtergrond
    B. Westerse migratieachtergrond -West-Europa, Verenigde Staten, Australië en Nieuw-Zeeland
    C. Niet-westerse migratieachtergrond -Azië, Oost-Europa, Afrika, Latijns-Amerika
    D. Anders (graag specificeren)

5. Wat is het hoogste opleidingsniveau dat u hebt voltooid of de hoogste graad die u hebt behaald?
    A. Lager dan middelbare school diploma
    B. Middelbare school diploma of vergelijkbaar
    C. Hogeschool diploma
    D. Bachelor degree
    E. Master degree
    F. Kandidaats/PhD

6. Wat is uw huidige beroep?
    A. Bediende
    B. Zelfstandige
    C. Ambtenaar
    D. Gepensioneerd
    E. Werkloos
    F. Langdurig ziek

7. Bij welk ziekenfonds bent u aangesloten?

Kennis over osteoporose

	Waar	Niet waar	Ik weet het niet
1. Osteoporose leidt tot een verhoogd risico op botbreuken.			
2. Osteoporose veroorzaakt meestal symptomen (bijv. pijn) voordat fracturen optreden.			
3. Het hebben van een hogere botmassa aan het einde van de kindertijd beschermt tegen het ontwikkelen van osteoporose op latere leeftijd.			
4. Osteoporose komt vaker voor bij mannen.			
5. Het roken van sigaretten kan bijdragen aan osteoporose.			
6. Blanke vrouwen lopen het meeste risico op fracturen in vergelijking met andere bevolkingsgroepen van andere origine.			
7. Een val is net zo belangrijk als een lage botsterkte bij het veroorzaken van fracturen.			
8. Op 80-jarige leeftijd heeft de meerderheid van de vrouwen osteoporose.			
9. Vanaf de leeftijd van 50 kunnen de meeste vrouwen minstens één breuk verwachten voordat ze overlijden.			
10. Elke vorm van fysieke activiteit is gunstig voor osteoporose.			
11. Het is gemakkelijk te zien of ik risico loop op osteoporose vanwege mijn klinische risicofactoren.			
12. Familiegeschiedenis van osteoporose maakt een persoon zeer vatbaar voor osteoporose.			
13. Voldoende calciuminname kan worden bereikt met twee glazen melk per dag.			
14. Sardines en broccoli zijn goede bronnen van calcium voor mensen die geen zuivelproducten kunnen nemen.			
15. Calciumsupplementen alleen kunnen botverlies voorkomen			
16. Inname van alcohol met mate heeft weinig effect op osteoporose.			
17. Een hoge zoutinname is een risicofactor voor osteoporose.			

18. Er is een kleine hoeveelheid botverlies in de tien jaar na het begin van de menopauze.			
19. Hormoontherapie voorkomt verder botverlies op elke leeftijd na de menopauze.			
20. Er zijn geen effectieve behandelingen voor osteoporose beschikbaar in “België”.			

<u>Houding en praktijk</u>

1. Hoe vaak komt botgezondheid ter sprake als u naar uw huisarts gaat?
    - Altijd
    - Vaak
    - Regelmatig
    - Zelden
    - Nooit

2. Osteoporose is een zeer belangrijk gezondheidsprobleem.
    - Akkoord
    - Neutraal
    - Niet akkoord

3. Ik heb een goede uitleg over de ziekte van osteoporose gekregen.
    - Akkoord
    - Neutraal
    - Niet akkoord

4. Ik heb een goede uitleg over mijn behandeling (doel, mogelijke bijwerkingen, methode van inname) voor osteoporose gekregen
    - Akkoord
    - Neutraal
    - Niet akkoord

5. Ik heb genoeg informatie gekregen over dieet advies met betrekking tot osteoporose.
    - Akkoord
    - Neutraal
    - Niet akkoord

6. Ik heb genoeg informatie gekregen over lichaamsbeweging met betrekking tot osteoporose
    - Akkoord
    - Neutraal
    - Niet akkoord

7. Ik heb genoeg informatie gekregen over valpreventie
    - Akkoord
    - Neutraal
    - Niet akkoord

8. Ik neem regelmatig een calcium supplement

- Ja
- Nee

9. Ik neem regelmatig een vitamine D supplement
   - Ja
   - Nee

10. Behalve calcium en vitamine D neem ik ook andere medicatie voor osteoporose zoals bijvoorbeeld prolia, fosamax, alendronate?
   - Ja
   - Nee

11. Wat zijn volgens u de grootste barrières voor het aanpak van osteoporose in de praktijk?
   - Onvoldoende kennis van zorgverleners
   - Multipele aandoeningen waardoor minder aandacht aan osteoporose geschonken is
   - Verminderd toegang tot goede behandelopties
   - Tekort aan tijd
   - Zorgen over bijwerkingen van medicatie
   - Anders (licht toe):

Hartelijk dank voor uw deelname. Hieronder vindt u de antwoordsleutel voor de 20-punt vragenlijst over osteoporose.

	Waar	Niet waar	Ik weet het niet
1. Osteoporose leidt tot een verhoogd risico op botbreuken.	X		
2. Osteoporose veroorzaakt meestal symptomen (bijv. pijn) voordat fracturen optreden.		X	
3. Het hebben van een hogere botmassa aan het einde van de kindertijd beschermt tegen het ontwikkelen van osteoporose op latere leeftijd.	X		
4. Osteoporose komt vaker voor bij mannen.		X	
5. Het roken van sigaretten kan bijdragen aan osteoporose.	X		
6. Blanke vrouwen lopen het meeste risico op fracturen in vergelijking met andere bevolkingsgroepen van andere origine.	X		
7. Een val is net zo belangrijk als een lage botsterkte bij het veroorzaken van fracturen.	X		
8. Op 80-jarige leeftijd heeft de meerderheid van de vrouwen osteoporose.	X		
9. Vanaf de leeftijd van 50 kunnen de meeste vrouwen minstens één breuk verwachten voordat ze overlijden.	X		
10. Elke vorm van fysieke activiteit is gunstig voor osteoporose.		X	

11. Het is gemakkelijk te zien of ik risico loop op osteoporose vanwege mijn klinische risicofactoren.	X		
12. Familiegeschiedenis van osteoporose maakt een persoon zeer vatbaar voor osteoporose.	X		
13. Voldoende calciuminname kan worden bereikt met twee glazen melk per dag.	X		
14. Sardines en broccoli zijn goede bronnen van calcium voor mensen die geen zuivelproducten kunnen nemen.	X		
15. Calciumsupplementen alleen kunnen botverlies voorkomen		X	
16. Inname van alcohol met mate heeft weinig effect op osteoporose.	X		
17. Een hoge zoutinname is een risicofactor voor osteoporose.	X		
18. Er is een kleine hoeveelheid botverlies in de tien jaar na het begin van de menopauze.		X	
19. Hormoontherapie voorkomt verder botverlies op elke leeftijd na de menopauze.	X		
20. Er zijn geen effectieve behandelingen voor osteoporose beschikbaar in “België”.		X	

References

[i] Wu AM, Bisignano C, James SL, Abady GG, Abedi A, Abu-Gharbieh E, et al. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990–2019: a systematic analysis from the Global Burden of Disease Study 2019. The Lancet Healthy Longevity [Internet]. 2021 Sep 1 [cited 2021 Oct 4];2(9):e580–92. Available from: https://www.thelancet.com/journals/lanhl/article/PIIS2666-7568(21)00172-0/fulltext#:~:text=Globally%2C%20in%202019%2C%20there%20were

[ii] Cheng CH, Chen LR, Chen KH. Osteoporosis Due to Hormone Imbalance: An Overview of the Effects of Estrogen Deficiency and Glucocorticoid Overuse on Bone Turnover. International Journal of Molecular Sciences. 2022 Jan 25;23(3):1376.

[iii] About | International Osteoporosis Foundation [Internet]. www.osteoporosis.foundation. Available from: https://www.osteoporosis.foundation/health-professionals/about-osteoporosis

[iv] Osteoporose [Internet]. www.uzleuven.be. Available from: https://www.uzleuven.be/nl/osteoporose

[v] Intego. Tool · INTEGO [Internet]. intego.be. Available from: https://www.intego.be/resultaten/tool

[vi] The Belgian Bone Club 2020 guidelines for the management of osteoporosis in postmenopausal women. Maturitas [Internet]. 2020 Sep 1 [cited 2021 Jul 12];139:69–89. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0378512220302644

[vii] Winzenberg TM, Oldenburg B, Frendin S, Jones G. The design of a valid and reliable questionnaire to measure osteoporosis knowledge in women: the Osteoporosis Knowledge Assessment Tool (OKAT). BMC Musculoskeletal Disorders [Internet]. 2003 Jul 24 [cited 2019 Nov 5];4(1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC183834/

[viii] Alghamdi A, Osama Almutairi, Rakan Abu Alqam, Jambi AT, Al-Harthi HK, Khalid binhamran, et al. Evaluation of Osteoporosis Perception Among Saudi Arabian Premenopausal Women: A Cross-Sectional Survey Study Using the Osteoporosis Knowledge Assessment Tool (OKAT). Cureus [Internet]. 2023 Sep 13 [cited 2023 Nov 18]; Available from: https://doi.org/10.7759%2Fcureus.45191

[ix] Tardi P, Szilagyi B, Makai A, Gyuro M, Acs P, Jaromi M, et al. The development of a reliable and valid instrument to measure the osteoporosis-related knowledge: validation of the Hungarian version of Osteoporosis Knowledge Assessment Tool (OKAT). BMC Public Health. 2021 Apr;21(S1).

[x] National Institute of Arthritis and Musculoskeletal and Skin Diseases. Osteoporosis [Internet]. National Institute of Arthritis and Musculoskeletal and Skin Diseases. 2022. Available from: https://www.niams.nih.gov/health-topics/osteoporosis

[xi] Belgian Bone Club. What is osteoporosis? [Internet]. www.bbcbonehealth.org. 2013 [cited 2024 Mar 6]. Available from: https://www.bbcbonehealth.org/what-is-osteoporosis

[xii] admin. Wereld Osteoporose Dag [Internet]. www.bbcbonehealth.org. 2019 [cited 2024 Mar 6]. Available from: https://www.bbcbonehealth.org/wereld-osteoporose-dag-0

[xiii] Wertelaers A, Baeten R, Vandeput O, Tessier J, Deconinck L, Heirstrate L, et al. PRAKTIJKINSTRUMENTEN VAL-EN FRACTUURPREVENTIE [Internet]. [cited 2024 Mar 6]. Available from:

https://www.domusmedica.be/sites/default/files/Praktijkinstrumenten%20val-en%20fractuurpreventie_0.pdfcited 2024 Mar 6]. Available from: https://www.domusmedica.be/sites/default/files/Praktijkinstrumenten%20val-en%20fractuurpreventie_0.pdf

[xiv] Shef.ac.uk. 2023. Available from: https://frax.shef.ac.uk/FRAX/index.aspx

[xv] Kanis JA, Johnell O, Oden A, De Laet C, Dawson A, Jonsson B. Ten Year Probabilities of Osteoporotic Fractures According to BMD and Diagnostic Thresholds. Osteoporosis International. 2001 Dec 1;12(12):989–95.

[xvi] Ji M, Yu Q. Primary osteoporosis in postmenopausal women. Maturitas. 2015 Nov;82(3):315.

[xvii] Pouresmaeili F, Kamali Dehghan B, Kamarehei M, Yong Meng G. A comprehensive overview on osteoporosis and its risk factors. Therapeutics and Clinical Risk Management [Internet]. 2018 Nov 6;14(1):2029–49. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6225907/#box1-tcrm-14-2029

[xviii] Balasubramanian A, Zhang J, Chen L, Wenkert D, Daigle SG, Grauer A, et al. Risk of subsequent fracture after prior fracture among older women. Osteoporosis International [Internet]. 2018 Nov 19 [cited 2022 Jun 19];30(1):79–92. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6332293/#:~:text=Introduction%20Prior%20fracture%20is%20a%20strong%20predictor%20of

[xix] Resnick B, Nahm ES, Zhu S, Brown C, An M, Park B, et al. The Impact of Osteoporosis, Falls, Fear of Falling, and Efficacy Expectations on Exercise Among Community-Dwelling Older Adults. Orthopaedic Nursing [Internet]. 2014;33(5):277–86. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4170528/

[xx] Kanis JA, Johansson H, Oden A, Johnell O, De Laet C, Eisman JA, et al. A family history of fracture and fracture risk: a meta-analysis. Bone. 2004 Nov;35(5):1029–37.

[xxi] van der Voort DJM, van der Weijer PHM, Barentsen R. Early menopause: increased fracture risk at older age. Osteoporosis International. 2003 Apr 30;14(6):525–30.

[xxii] Nutrition | International Osteoporosis Foundation [Internet]. www.osteoporosis.foundation. Available from: https://www.osteoporosis.foundation/health-professionals/prevention/nutrition

[xxiii] DiNicolantonio JJ, Mehta V, Zaman SB, O'Keefe JH. Not Salt But Sugar As Aetiological In Osteoporosis: A Review. Missouri medicine [Internet]. 2018 [cited 2024 Mar 7];115(3):247–52. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6140170/#:~:text=Dietary%20consumptions%20of%20sodium%20chloride%20%28salt%29%20and%20excess

[xxiv] Pfeifer M, Sinaki M, Geusens P, Boonen S, Preisinger E, Minne HW. Musculoskeletal Rehabilitation in Osteoporosis: A Review. Journal of Bone and Mineral Research. 2004 May 10;19(8):1208–14.

[xxv] Fujiyoshi A, Polgreen LE, Gross MD, Reis JP, Sidney S, Jacobs DR. Smoking habits and parathyroid hormone concentrations in young adults: The CARDIA study. Bone Reports. 2016 Dec;5:104–9.

[xxvi] Al-Bashaireh AM, Haddad LG, Weaver M, Chengguo X, Kelly DL, Yoon S. The Effect of Tobacco Smoking on Bone Mass: An Overview of Pathophysiologic Mechanisms. Journal of Osteoporosis [Internet]. 2018 Dec 2;2018:1–17. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6304634/

[xxvii] Paccou J, Edwards MH, Ward K, Jameson K, Moon R, Dennison E, et al. Relationships between bone geometry, volumetric bone mineral density and bone microarchitecture of the distal radius and tibia with alcohol consumption. Bone [Internet]. 2015 Sep 1 [cited 2021 Dec 1];78:122–9. Available from: https://pubmed.ncbi.nlm.nih.gov/25959415/

[xxviii] Ravn P, Cizza G, Bjarnason NH, Thompson D, Daley M, Wasnich RD, et al. Low body mass index is an important risk factor for low bone mass and increased bone loss in early postmenopausal women. Early Postmenopausal Intervention Cohort (EPIC) study group. Journal of Bone and Mineral Research: The Official Journal of the American Society for Bone and Mineral Research [Internet]. 1999 Sep 1 [cited 2020 Apr 22];14(9):1622–7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10469292

[xxix] Panday K, Gona A, Humphrey MB. Medication-induced osteoporosis: screening and treatment strategies. Therapeutic Advances in Musculoskeletal Disease [Internet]. 2014 Aug 11;6(5):185–202. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4206646/

[xxx] PJM E, GJ D, T VG, LWF M, T M, RMM G, et al. Fractuurpreventie [Internet]. NHG-werkgroep; 2012 [cited 2024 Mar 7]. Available from: https://richtlijnen.nhg.org/standaarden/fractuurpreventie#volledige-tekst-stap-5a-voorlichting-en-advies

[xxxi] Benedetti MG, Furlini G, Zati A, Letizia Mauro G. The Effectiveness of Physical Exercise on Bone Density in Osteoporotic Patients. BioMed Research International [Internet]. 2018 Dec 23;2018(4840531):1–10. Available from: https://www.hindawi.com/journals/bmri/2018/4840531/

[xxxii] Hernandez CJ, Beaupré GS, Carter DR. A theoretical analysis of the relative influences of peak BMD, age-related bone loss and menopause on the development of osteoporosis. Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA [Internet]. 2003 [cited 2019 Dec 25];14(10):843–7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/12904837

[xxxiii] Osteoporose en botbreuken [Internet]. [cited 2024 Mar 7]. Available from: https://reumanet.be/sites/reumanet/files/Brochure_Osteoporose_FINAL.pdf

[xxxiv] Paik J, Scott LJ. Romosozumab: A Review in Postmenopausal Osteoporosis. Drugs & Aging. 2020 Sep 10;37(11):845–55.

[xxxv] Ganesan K, Bansal P, Goyal A, Roane D. Bisphosphonate [Internet]. PubMed. Treasure Island (FL): StatPearls Publishing; 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470248/

[xxxvi] Home | IOF Osteoporosis Risk Check [Internet]. riskcheck.osteoporosis.foundation. [cited 2024 Mar 2]. Available from: https://riskcheck.osteoporosis.foundation/nl

[xxxvii] Calcium: bouwsteen van de botten | Voedingsinfo NICE [Internet]. www.nice-info.be. [cited 2024 Feb 24]. Available from: https://www.nice-info.be/nutrinews/calcium-bouwsteen-van-de-botten#:~:text=Voor%20alle%20leeftijdsgroepen%20samen%20geldt%20dat%2056%25%20van