Review article

Determinants of postmenopausal osteoporosis

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Introduction: Osteoporosis is generally associated with menopause. Scientific research has shown the existence of several factors involved in decreasing bone density in post-menopausal women.

Goal: The aim of the review study is to map in detail the prevalence of osteoporosis in postmenopausal women in the context of postmenopausal age, postmenopausal duration, women's BMI and selected behavioural factors.

Methods: Relevant sources were selected in 2020 using search services and sources in electronic databases (PubMed, BioMed Central, Web of Science). The analytical review was performed using PRISMA and PICO tools.

Results and discussion: In analysing the available studies, we found that the most frequently observed significant findings showed a relationship between the prevalence of osteoporosis and age at menopause and the prevalence of osteoporosis and advancing age in postmenopause. Opinions differ on the influence of BMI as a protective or risk factor. Some behavioural factors that are preventable can have a significant effect on bone mineral density in postmenopausal women. The results of several studies suggest an association between the prevalence of osteoporosis and smoking and alcohol consumption.

Conclusions: Menopause is a critical period for bone health. The incidence of osteoporosis increases with increasing age of postmenopausal women. As part of prevention, it is recommended to have a suitable type of diet, exposure to sunlight, regular exercise and to stop smoking and drinking alcohol.

Keywords: Age; BMI; Diet; Menopause; Osteoporosis

Introduction

With the increased life expectancy of the world's population in recent decades, there has been growth in the incidence of illnesses of the most advanced ages, including osteoporosis (Cunha-Henriques et al., 2011). Its prevalence is most often associated with menopause (Török-Oancea and Bala, 2015). Menopause as a biological process occurs at the age of approximately 40 to 60 years (mean value 51 years). Menopause is defined as the permanent cessation of menstruation. The diagnosis is made retrospectively after menstruation has been absent for 12 months (Koothirezhi and Ranganathan, 2021; Moron et al., 2009). Menopausal age is important as a retrospective marker for ovarian senescence. An early menopausal age is associated with an increased risk of cardiovascular diseases and osteoporosis. A later menopausal age has been associated with an increased risk of breast cancer. Experts consider genetic factors to be the main source of age variation. Environmental factors explain only a small part of the variance (Kok et al., 2005; van Asselt et al., 2004; Voorhuis et al., 2010). According to Koothirezhi and Ranganathan (2021), health concerns among menopausal women are mainly related to

vasomotor symptoms, urogenital atrophy, osteoporosis, cardiovascular disease, cancer, psychiatric symptoms, cognitive decline, and sexual problems. Menopause is a critical period for bone health, with rapid losses in bone mass and strength occurring in a 3-year window bracketing the date of the final menstrual period. Monitoring of bone density is important in predicting the onset of the rapid loss phase and in identifying the women who are most at risk of osteoporosis during menopause, as well as in assessing the effectiveness of osteoporosis treatment (Karlman et al., 2018).

According to Brown et al. (2009), osteoporosis is the most common cause of fractures. It is estimated that in the USA and the European Union around 30% of women who have reached menopause are suffering from osteoporosis. In Asia, the overall prevalence of osteoporosis is higher than in the western countries (Török-Oancea and Bala, 2015). A low Body Mass Index (BMI) is a risk factor for bone loss (Aghaei et al., 2013). The protective effect of overweight on osteoporosis is not clear (Salamat et al., 2013; Schoenaker et al., 2014).

The described starting points provided the impetus for an analytical review that provides a systematic review of published studies on the topic. We mapped the key factors: osteoporosis, menopause, age of the woman, obesity, and smoking.

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Materials and methods

The analytical review was performed using PRISMA and PICO tools. The present study is an evaluation of current theories on osteoporosis in postmenopausal women. Secondary analysis and detailed examination of relevant sources using the PubMed, BioMed Central and Web of Science electronic databases using certain keywords were used to determine the key terms. The keywords were osteoporosis, menopause, age and BMI, which have been extended to include the concepts of obesity and smoking. The operators defining the logical re-

lationships between the individual keywords were “and/or”. Empirical results, as well as theoretical knowledge identifying the degree of knowledge in relation to the studied variables in English, were searched for. Published studies for the last 10 years (from 2010 to 2020 inclusive) were analyzed. The second phase of the review included studies with the condition that free full texts were available. The analytical and research phase was conducted from May to November 2020. The search process is shown in the PRISMA literature review flow diagram (Fig. 1). After a thorough assessment by the authors, the analysis included the 5 most relevant studies, which most reflected the defined clinical issues (Table 1).

Fig. 1. PRISMA flow diagram for the selection of studies

The aim of the review study was to map in detail the prevalence of osteoporosis in postmenopausal/climacteric women in the context of age at menopause, duration of postmenopause/climacterium, women's BMI and selected behavioural factors, in available published outcomes.

The main clinical question was compiled using a standardized PICO format.

Basic clinical question

Is there a higher prevalence of osteoporosis in postmenopausal women with increasing age?

Specific clinical questions:

- Does age of onset of menopause affect the prevalence of osteoporosis in menopausal women?
- Does the increasing postmenopausal age of women affect the progression of osteoporosis?
- Does the weight and BMI of postmenopausal women affect the prevalence of osteoporosis?
- Do selected lifestyle-related behavioural factors affect the prevalence of osteoporosis in menopausal women?

Table 1. Studies included in the analysis

Authors	Title of study	Database
Agrawal and Verma (2013)	Cross sectional study of osteoporosis among women	NCBI
Guiming et al. (2019)	Association of breastfeeding and postmenopausal osteoporosis in Chinese women: a community-based retrospective study	BMC
Tian et al. (2017)	Prevalence of osteoporosis and related lifestyle and metabolic factors of postmenopausal women and elderly men: A cross-sectional study in Gansu province, Northwestern of China	WOS
Török-Oancea and Bala (2015)	Body weight, BMI, and stature have a protective effect on bone mineral density in women with postmenopausal vertebral osteoporosis, whereas greater age at menarche and years after menopause have a negative effect	WOS
Veiga Silva et al. (2015)	Factors associated with osteopenia and osteoporosis in women undergoing bone mineral density test	WOS

Results and discussion

Osteoporosis, as a public health problem, is generally associated with menopause. It affects one out of three postmenopausal women (Rizzoli et al., 2014). A positive relationship of osteoporosis with older age of postmenopausal women is reported in the literature. With increasing age, the risk of other associated diseases increases, which can worsen the quality of life (Haluzikova, 2017). According to Cunha-Henriques et al. (2011), older women with osteoporosis may suffer from a deterioration in musculoskeletal status, which in the long term may result in limitations to their daily activities, as well as lumbar pain, an increase in the occurrence of falls, and a consequent increase in fracture risk. Scientific studies show that there are many factors associated with decreased bone mineral density and osteoporosis in postmenopausal women.

We analyzed in detail the available scientific studies (Table 2) focused on the prevalence and risks of postmenopausal osteoporosis.

The aim of the analysis was to determine how age, BMI values, duration of climacterium as well as selected lifestyle-related behavioural factors affect the progression of osteoporosis in menopausal women.

Age at menopause – increasing postmenopausal age

The results of the studies showed a very significant association between the incidence of osteopenia and osteoporosis and age, as well as the number of years after menopause (Demirbag et al., 2006). Hamdi Kara et al. (2008) also report increasing age (over 65 years) combined with illiteracy as risk factors for osteopenia and osteoporosis (2008). Baccaro et al. (2015) report a positive association between osteoporosis and age >45 years.

Table 2. Objectives and results of the studies

Authors	Country of study	Type of study	Objective	Results
Agrawal and Verma (2013)	Uttarakhand – India	Cross-sectional descriptive study	A study of the prevalence of osteopenia and osteoporosis and their correlation with epidemiological and socio-behavioural factors in women over 35 years of age	The prevalence of osteopenia and osteoporosis is related to age; number of pregnancies; age at menopause; greater weight; there was a positive correlation with a physically active lifestyle
Guiming et al. (2019)	Tianjin Xiaobailou – China	Retrospective cross-sectional study	To assess the effect of age, BMI, vitamin D and calcium intake, history of smoking, alcohol drinking and fractures, age at menarche, age at menopause, number of pregnancies, parity, diet and overall duration of breastfeeding on the incidence of osteoporosis in postmenopausal women	Breastfeeding is not associated with postmenopausal osteoporosis; increasing age, higher BMI and higher number of pregnancies are associated with an increased risk of postmenopausal osteoporosis
Tian et al. (2017)	Gansu – China	Cross-sectional study	To examine the prevalence of osteoporosis and the risks in postmenopausal women and older men.	The risk of osteoporosis is related to age of onset of menopause, increasing age in menopause, higher BMI and level of education in postmenopausal women
Török-Oancea and Bala (2015)	Timișoara – Romania	Retrospective cross-sectional study	To assess the effect of age, menarche time, age at menopause, number of reproductive years (reproductive period), number of years after menopause, body weight, figure and BMI on spinal bone density (BMD) in women with postmenopausal vertebral osteoporosis	Weight and higher BMI have a protective effect on bone density; increasing age, age of onset of menopause, increasing number of years after onset of menopause have a negative effect on spinal density
Veiga Silva et al. (2015)	South of Brazil	Cross-sectional study	To determine the prevalence of osteopenia and osteoporosis in a female population in which bone mineral density (BMD) was measured by dual energy X-ray absorptiometry (DXA) at a specialized clinic in southern Brazil	The prevalence of osteopenia is higher than the prevalence of osteoporosis; aging and menopause are risk factors for both groups; BMI above 25 and previous hysterectomy are protective factors

The results of a retrospective study in Caucasian women with postmenopausal vertebral osteoporosis also showed a very significant relationship between the incidence of osteopenia and osteoporosis and age and number of years after menopause (Török-Oancea and Bala, 2015).

A study conducted by Guiming et al. (2019) showed that the prevalence of postmenopausal osteoporosis in postmenopausal women with advanced age was significantly higher than in the lower age group. However, according to the authors, the age at the onset of menopause was not significant in the group without osteoporosis compared to the group with osteoporosis.

According to Tian et al. (2017), the risk of osteoporosis was significantly associated with menopause onset age and menopause duration. Menopause and age over 50 years were reported as risk factors for both osteopenia and osteoporosis in the results of a study by Veiga Silva et al. (2015). They report a linear increase in osteopenia and osteoporosis with advancing age of postmenopausal women. According to the results of their study, Agrawal and Verma (2013) showed that the statistical relationship between the prevalence of osteopenia and osteoporosis is significant in relation to the age of women, the number of pregnancies and the age of menopause. According to Binu et al. (2019), the number of years since menopause had an adverse effect on the skeleton.

Weight and BMI

Opinions differ on the influence of BMI as a protective or risk factor for the prevalence of osteoporosis. According to the results of some studies, weight, BMI and body shape have a protective effect on the spinal density of bone tissue (Török-Oancea and Bala, 2015). Also, according to Veiga Silva et al. (2015), postmenopausal women with a BMI above 25 had a statistically significantly lower incidence of osteopenia or osteoporosis. In contrast, according to Guiming et al. (2019), the prevalence of postmenopausal osteoporosis was significantly higher in postmenopausal women with higher BMI and higher number of pregnancies. Higher BMI as a risk factor for osteoporosis in postmenopausal women is reported by Tian et al. (2017) and Agrawal and Verma (2013).

Behavioural factors

Many preventable environmental risk factors can have significant effects on bone mineral density in postmenopausal women. The results of several studies suggest that smoking is an independent risk factor for osteoporosis in postmenopausal women (Bijelic et al., 2017; Rizzoli et al., 2014). Tian et al. (2017) report alcohol as a significant risk factor for osteopenia and osteoporosis in menopausal women.

The study by Kalem et al. (2017) found no significant differences between groups of postmenopausal women with osteoporosis due to smoking, coffee consumption and consumption of milk and dairy products. According to Guiming et al. (2019), diet was not significant in the group of postmenopausal women without osteoporosis compared to the group with osteoporosis.

Furthermore, the increased risk of postmenopausal osteoporosis was not significantly associated with a longer duration of breastfeeding lasting more than 24 months (Guiming et al., 2019).

It is important to understand the associated risk factors, clinical presentation, and the management of common menopausal symptoms in order to improve patient care and health outcomes for older female patients (Koothirezhi and Rangathan, 2021).

Prevention of osteoporosis

The prevention and treatment of osteoporosis consists of non-pharmacological and pharmacological measures. According to Agrawal and Verma (2013), the benefits of the three components of non-pharmacological therapy are well established – these include diet, exposure to sunlight, regular exercise and cessation of smoking and alcohol consumption. Healthy lifestyle (diet, exercise and sunlight exposure) can have a major positive impact on bone health. According to Török Oancea and Bala (2015), regular assessment of bone mineral density (BMD) is important because it may help in assessing the risk of osteoporosis and subsequent fractures. According to Rizzoli et al. (2014), it is possible to reduce the risk of osteoporosis by lifestyle modifications. These include adequate dietary intake of calcium, vitamins and proteins, regular exercise, reduction in alcohol intake and refraining from smoking. These public health measures are recommended for the general population because they are effective, safe and cost-effective. Therefore, there is an urgent need to raise public awareness of this. In the case of middle-aged and elderly people, early detection and treatment of osteoporosis with available substances can significantly reduce the risk of fractures and associated morbidity and mortality.

Conclusions

According to research, postmenopausal osteoporosis is a global public health problem. Analysis of the results of studies shows the relationship between the prevalence of osteoporosis or osteopenia and age at onset of menopause and increasing age in the postmenopausal period. The relationship between higher BMI as a protective factor in relation to the prevalence of osteoporosis is not clear. Therefore, it would be advisable to analyse the relationship of these variables to cultural and ethnic factors; we consider the absence of this in the present study to be a limiting factor. With regards to preventable behavioural factors, a higher prevalence of osteoporosis was found in postmenopausal women who smoked, and in association with higher alcohol consumption. The degree of prevalence of postmenopausal osteoporosis in relation to diet or consumption of dairy products (as a source of protein) has not been clearly demonstrated. Physical activity and exercise in postmenopausal women have been clearly confirmed as a protective factor.

Population studies are essential to identify risk factors for falls and fractures in different populations to help physicians providing care for postmenopausal women.

Author contributors

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Ethical aspects and conflict of interests

The authors have no conflict of interests to declare.

Determinanty postmenopauzálnnej osteoporózy

Súhrn

Úvod: Osteoporóza je všeobecne spájaná s menopauzou. Vedecké štúdie preukázali existenciu viacerých faktorov podieľajúcich sa na znižovaní kostnej denzity u žien v postmenopauze.

Cieľ: Cieľom prehľadovej štúdie je podrobne zmapovať prevalenciu osteoporózy u žien v menopauze a prevalenciou osteoporózy a postupujúcim vekom v menopauze, dĺžky trvania postmenopauzy, BMI ženy a vybraných behaviorálnych faktorov.

Metódy: Výber relevantných zdrojov bol realizovaný v roku 2020 pomocou vyhľadávacích služieb a zdrojov v elektronických databázach (PubMed, BioMed Central, Web of Science). Analytická prehľadová štúdia bola spracovaná s využitím techniky PRISMA a PICO.

Výsledky a diskusia: Analýzou dostupných výskumných štúdií sme zistili, že najčastejšie pozorované signifikantné výsledky preukázali závislosť medzi prevalenciou osteoporózy a vekom v menopauze a prevalenciou osteoporózy a postupujúcim vekom v postmenopauze. Názory na vplyv BMI ako protektívneho, resp. rizikového faktora sa rôznia. Významný vplyv na hustotu kostných minerálov u žien po menopauze môžu mať niektoré behaviorálne faktory, ktoré sú preventabilné. Z výsledkov viacerých štúdií vyplýva súvislosť medzi prevalenciou osteoporózy fajčenia a konzumácie alkoholu.

Záver: Menopauza je kritickým obdobím pre zdravie kostí. Zvyšujúcim sa vekom žien v postmenopauzálnom období sa výskyt osteoporózy zvyšuje. V rámci prevencie sa odporúča vhodný druh stravovania, vystavenie sa slnečnému žiareniu, pravidelné cvičenie a pohyb a ukončiť fajčenie a konzumáciu alkoholu.

Kľúčové slová: BMI; menopauza; osteoporóza; vek; životospráva

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