REVIEW ARTICLE

Osteoporosis e-learning courses: A systematic review to develop a comprehensive virtual course for General Practitioners

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Abstract

Purpose One of the key strategies for effective management of osteoporosis is training health care professionals on early diagnosis and treatment of osteoporosis according to a structured course. The aim was to investigate the e-learning courses on osteoporosis around the world in order to develop an online course on osteoporosis management for general practitioners (GPs).

Methods In this review, the Web of Science, Scopus, PubMed, Embase, and ERIC databases and the Google search engine were searched until March, 2021.Then, the contents of the eligible courses were extracted by two researchers independently and verified. After that, the content for an online course for GPs was developed and approved by a panel of experts constituted of endocrinologists, orthopedists, and other specialties involved in the management of osteoporosis to develop the final online course for GPs.

Results In this review, 22 e-learning courses provided through 3 studies, and 19 websites were included. The content of the osteoporosis e-learning course was categorized into ten thematic categories including bone health, osteoporosis definitions and pathophysiology, prevention of osteoporosis, diagnosis of osteoporosis, fractures, non-pharmacological treatments, pharmacological treatments, treatment follow-up, postmenopausal considerations and hands-on work. The final modules for the osteoporosis e-learning contained five main categories, including bone measurement and fracture risk assessment, diagnosis of osteoporosis, clinical management, monitoring and follow-up, and sarcopenia.

Conclusion Through a systematic approach, we developed modules for e-learning of osteoporosis management, which can be used to improve knowledge and skills of GPs in their practice in our setting.

Keywords Osteoporosis · Healthcare providers · E-learning

Introduction

Osteoporosis affects around 200 million women worldwide [1]. Fractures caused by osteoporosis are more common in men at younger age, and almost double in women over the age of 50 [2]. Osteoporosis is clinically silent, and due to its morbidity and mortality, it has become a major concern for health care system in terms of reducing health care resources [3]. Moreover, fractures caused by osteoporosis can lead to mobility restrictions, pain, and even mortality [2, 4]. It has been estimated that the annual cost of osteoporosis-related fractures in the UK is around £4 billion and in the U.S., it is $17.9 billion [2]. Despite the significant advances in osteoporosis screening, diagnosis, and fracture reduction

interventions due to the emergence of clinical guidelines, few patients at high risk of fracture are being treated, owing to the complexity of osteoporosis management, uncertainty in diagnosing and treating, ambiguities in clinical practice guidelines, and lack of health care providers` expertise in osteoporosis management [2, 5–7].

One of the key strategies to improve the management of osteoporosis is training healthcare professionals who are involved in the management and care of patients [8, 9]. In 2000, the National Institutes of Health identified the most effective way of educating healthcare specialists about the management of osteoporosis as a research priority [8, 10]. Healthcare professionals need to be empowered with new knowledge and competencies to provide patient care, effectively [8, 11]. Therefore, continuous professional development (CPD) of health care professionals is

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essential to improve their competency, and patient outcomes [7, 12, 13].

Because of the emergence of technology, traditional learning methods such as teacher-centered learning using textbooks in the classroom have been replaced by an e-learning approach [14]. E-learning is a cost-effective method without geographical boundaries, available at any time and place to transfer knowledge and CPD [15]. Transferring new knowledge or skills through e-learning is effective [16–18]. The COVID-19 pandemic revolutionized e-learning [19, 20] undoubtedly, the COVID-19 pandemic accelerated the process of e-learning and provided an opportunity for effective e-education [19, 21]. On the other hand, due to the high workload of healthcare providers and their time constraints, e-learning is a suitable alternative to face-to-face education for CPD [22].

In this study, due to the high prevalence of osteoporosis, especially in the elderly, and osteoporosis-related fractures [23], as well as the lack of national guideline awareness among healthcare providers in our setting [24, 25] and the potential capability of e-learning to improve the knowledge and skills of health care professionals [9], we developed e-learning modules based on the needs of society. Therefore, we reviewed osteoporosis e-learning courses from around the world to create an e-learning course in the field of osteoporosis management for general practitioners. We leveraged the experiences of the whole world regarding the course objectives, training duration, educational curriculum and evaluation method. This will be an effective step towards GPs` training in the field of prevention, diagnosis and timely treatment of osteoporosis, which will help to decrease primary and secondary costs and reduce the pain and suffering of people in the community with osteoporosis and subsequent complications.

Methods

Study design and eligibility criteria

This was a systematic review of articles with full text available in the English language, which included osteoporosis e-learning for GPs and/or medical or pharmacy students. We excluded surveys, patient education, letters to the editors, and review studies from our review process. Also, we included websites for all medical groups, and those that could not be accessed due to access limitations were excluded. In the e-learning that was the result of checking Google websites, we also included training courses included other care teams in addition to general practitioners.

Information sources and search strategy

According to the aim of the study, we reviewed e-learning of osteoporosis worldwide, at first. Web of Science, Scopus, PubMed, Embase, and ERIC databases, as well as the first three pages of the Google search engine, were sources. We searched until March 28th, 2021. The search strategy of each database and Google search engine were developed by a medical librarian (R.A), which can be seen in Table S1 and Table S2 (Appendix), respectively.

Screening and selection process

The two researchers in the team (R. N, and M. A) screened all the records retrieved from databases and the Google search engine. They first removed duplicates via endnote, then screened, the remaining records for eligibility criteria according to their titles and abstracts. In case of any doubt regarding eligibility criteria, the full texts of the studies and the contents of the websites were assessed. Any disagreements in this stage were resolved by the principal investigator of the project (M.S).

Data items and data extraction process

After selecting eligible studies and websites, we considered the following items for data extraction: Which centers provided osteoporosis e-learning services? What were the objectives of the osteoporosis e-learning course? What was the target group of the osteoporosis e-learning? What was the duration of the osteoporosis e-learning course? What did the osteoporosis e-learning curriculum include? What techniques were used to evaluate osteoporosis e-learning?".

The content of the courses included in the study, whether from articles or websites, was screened by the two researchers in the team (R. N, and M. A) and verified by the third researcher (M.S). Data were extracted by data extraction form which included the goal and learning domains, the program's mission, the target groups, the knowledge, and skills included in the curriculum content on osteoporosis, details of the syllabus and modules, instruction tools and methods, and evaluation methods [26, 27]. After collecting and extracting the related programs on osteoporosis management, we reviewed and analyzed each program and their results were shown in a table. Finally, we designed a new model and its graphical presentation according to our results. Based on national guidelines, the results of this study and the panel of experts an online course content for GPs was developed and approved

in our setting. In each session of the expert panel, the content was discussed and reviewed by a multidisciplinary team consisting of endocrinologists, orthopedists, rheumatologists and other specialties involved in the treatment and management of osteoporosis.

Results

Study and website selection

According to the search strategies developed for the databases and Google search engine, we identified 4475 records from all databases. After removing duplicates ($n = 2029$), there were 2446 records for screening titles and abstracts.

Then, the full texts of 15 studies were assessed for eligibility criteria. Finally, three studies were included in the review process. By using the Google search engine, we found 19 eligible online courses for health care specialists. Thus, 22 records including 19 websites and 3 studies were included in the study and their contents were extracted. The PRISMA flow diagram of the searching, screening, and selecting process has been shown in Fig. 1.

Data extraction

The details of courses extracted from the studies and websites are shown in Table 1. According to the content analysis of the courses included in the study, information about the goals of the e-learning courses, the target group (s), the
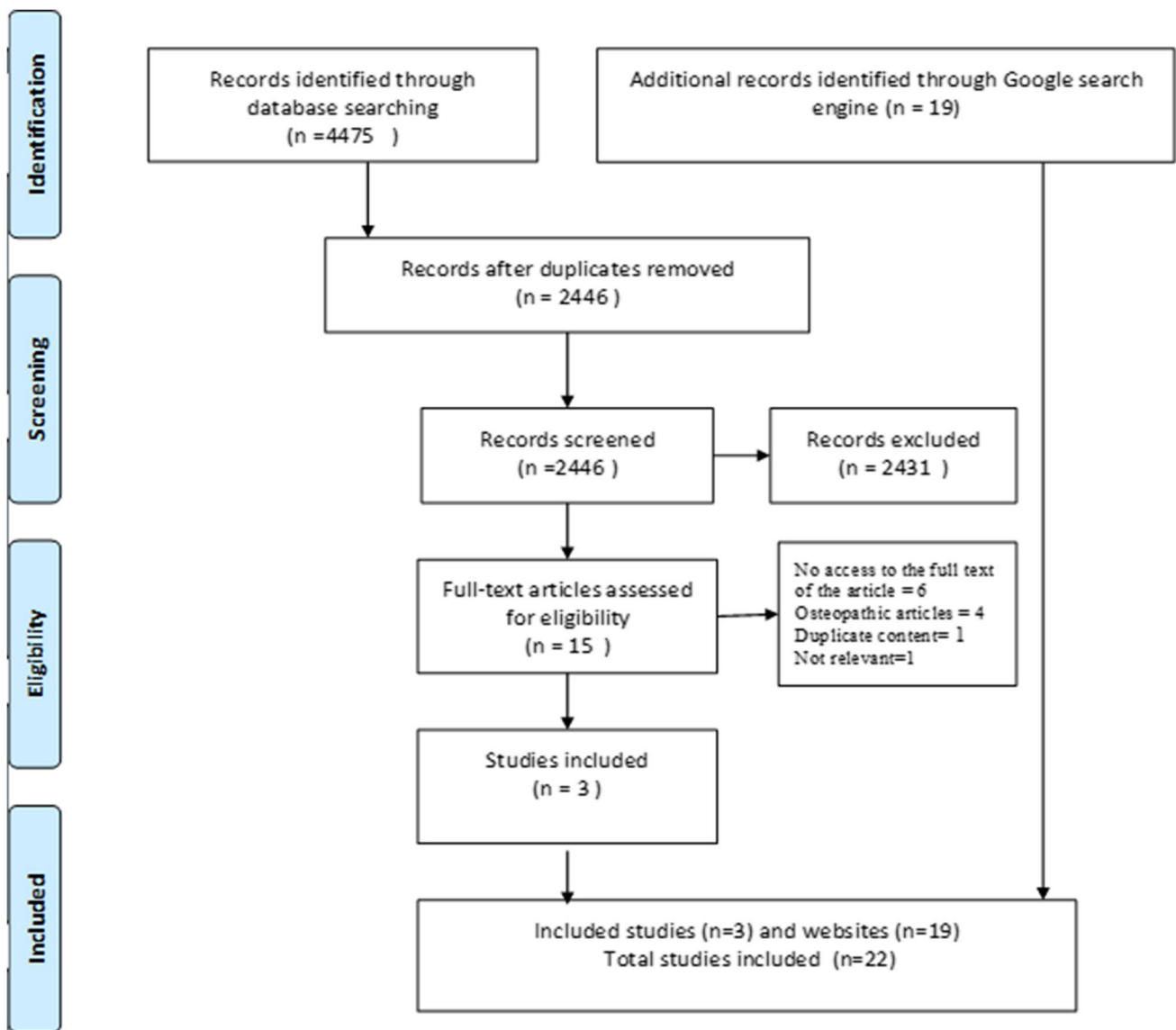

Fig. 1 The screening process of articles included in the study

Table 1 Osteoporosis e-learning courses in the eligible studies and websites

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
1	University of Georgia/ IBOP[1] [31]	To determine the difference in the attitude of pharmacy students and pharmacists towards online and "live" lectures and the level of comfort of each	Pharmacists and pharmacy students	second-year course	-Pathophysiology of post-menopausal osteoporosis -Risk factors of postmeno-pausal osteoporosis -Complications of post-menopausal osteoporosis -Preventing and treating post-menopausal osteoporosis	On-line lecture	Quiz with 10 multiple choice questions and grade of at least 70 percent
2	Boston/ randomized control trial [32]	Investigate whether an online bone health curriculum improves physicians' knowledge on the Quality of Resident-Delivered Care	-Internal medicine -Residents -Physicians	3- to 6-month	-Bone health care -Osteoporosis care -Fracture prevention	Online formative self-assessment and learning	Continuous self-assessment of residents' knowledge, 10 months after the educational intervention patient outcome
3	Project Extension for Community Healthcare Outcomes [11]	Improving participants' knowledge in the management of skeletal diseases	healthcare professionals	3- to 6-month	-Radiation therapy and anabolic therapy -Bone density and utilization of bone health resources -Treatment of osteoporosis -Osteoporosis management	weekly interactive videoconferencing technology, collaborative learning and share information, provide support and guidance	NA
4	National Osteoporosis Society /Diagnosis and management of osteoporosis [29]	Better bone health of everybody	GPs	30 min	-Identify groups at risk for osteoporosis -Early diagnosis and treatment of osteoporosis -Prevention of fractures due to fragility -Application of NICE, SIGN and NOGG instructions -FRAX and QFracture risk assessment methods -Using different scenarios -Monitoring the risk of fragility fractures	Case based approach	Online assessment

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
5	Health Education England in partnership with the NHS and Professional Bodies/ Image Interpretation- Osteoporosis and Fragility Fracture [33]	Image Interpretation	Radiographers	NA	-Definition of osteoporosis -Description of normal and hollow bone anatomy -Diagnosis of osteoporosis -Common causes of osteoporosis -Demographics relating to osteoporosis -Fragility fractures and common mechanisms of injury -Osteoporotic vertebral fractures -Best practice for identification vertebral fractures -Detection of vertebral fractures by imaging	NA	Self-evaluation exercise Images interpretation
6	National Osteoporosis Society, accredited by the Royal College of Nursing For four CPD points by the Royal College of Physicians in the UK / Fracture Prevention Practitioner Training [34]	-Caring for people with osteoporosis or at risk for osteoporosis -Identify patients with fragility fractures -Fracture fragility and its management based on the best method	- Fracture Liaison nurses -Specialist nurses -Allied health professionals -Clinicians -Healthcare professionals	NA	-Definition, incidence, epidemiology and risk factors for osteoporosis -Fracture assessment tools, nutritional assessment, DXA scan -Pharmacological and non-pharmacological treatment of osteoporosis -Managing the complex cases of osteoporosis	NA	Online assessment
7	EACCME² /Excellence in osteoporosis optimizing patient outcomes [35]	NA	medical specialist/Physicians	NA	-Why do bones fracture? -Diagnosis and assessing fracture risk -Treatment -Use of bisphosphonates and SERMs -Considerations in the clinic	NA	NA

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
8	Bone Research society and Federation of the Royal Colleges of Physicians of the United Kingdom /Online BRS[3] Clinical Training Course: Osteoporosis and Other Metabolic Bone Diseases 2021 [36]	Management of osteoporosis and other metabolic bone diseases	Rheumatology Endocrinology Care of the elderly, Gastroenterology, Orthopedics Respiratory medicine, Clinical chemistry, Nurses and other allied health professionals	3 weeks	-Management and treatment of osteoporosis focusing on practical tips	Combining lectures -Panel discussions – Debates -Workshops -Interactive sessions	NA
9	NA/Osteoporosis: Therapeutic Management of Bone Health [37]	- osteoporosis and management of bone health - bone anatomy and physiology—classifications, causes, and effects of low bone density - medical management and medications - therapist's role in managing osteoporosis and related conditions	Physicians	7 h	-Human bone physiology and bone changes in old age -Classification of osteopenia and osteoporosis and its demographic information in the United States -Diagnostic parameters of osteoporosis and its disadvantages -Physiological effects of osteoporosis -Risk factors, complications and mortality associated with fractures -Osteoporotic drug interventions -Exercise and its effect on bone health, contraindications or exercise precautions -Evaluation of a patient with osteoporosis -Case care program for patients with osteoporosis -Special exercises for patients with osteoporosis at the beginner level such as stretching, balance, strengthening and aerobic exercises	-Textbook -Booklet -eBook -PDFs -Multimedia or online (electronic) formats	Passing the online exam

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
10	Med Fit Education Foundation /Osteoporosis Fitness Specialist Online Course [38]	Diet and exercise and its effect on restoring and maintaining bone health function	Fitness professionals/ trainers	10 h	-Bone physiology and bone response to stress including Wolf's law -Conditions of osteopenia and osteoporosis -The role of exercise and diet in maintaining bone health and regeneration -The role of drugs and nutrients in bone health - S.A.F.E. Exercise and its role in bone health	- Course manual -Video slides -Videos of sports examples	Multiple choice question, competency assessment with at least 80% correct answer
11	Endocrine society/Better Bones: A Course On Osteoporosis & Metabolic Bone Disease [3]	-Provide comprehensive and up-to-date information on bone diseases -Basic and advanced principles of diagnosis and treatment of osteoporosis -Presenting the latest clinical guidelines for hypothyroidism and hyperparathyroidism	-Physician -Fellow -Resident -Clinical researcher -Scientific researcher -Educator -Pharmacist -Nurse practitioner -Physician assistant -Allied health professional	NA	-Prevalence, pathophysiology and progression of metabolic bone diseases including osteoporosis -Identify people at risk for bone fractures with imaging and new diagnostic guidelines -Therapeutic interventions such as nutrition, exercise, to reduce the risk of fractures in people with metabolic bone diseases -Individual treatment strategy for the management of osteoporosis and metabolic bone diseases	Interactive and multi-faceted learning opportunities	NA
12	The Royal Osteoporosis Society of UK and RCGP[4] /e-Learning osteoporosis module [30]	-Improve the bone health and prevent osteoporosis - professionals to deliver high quality healthcare -Provide the best information, support and services to help people -Drive the research and development of new treatments and therapies	NA	NA	-Prevention, diagnosis and management of osteoporosis and its associated fractures -Use NICE, SIGN and NOGG -Identification of risk groups FRAX and QFracture risk assessment tools - Monitoring of patients with osteoporosis and osteopenia	Case based approach	NA

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
13	NA/Advanced Learning Module: Osteoporosis & Exercise [8]	NA	NA	3 months	-Management of osteoporosis and fracture risk / -Caring for people with osteoporosis / -Familiarity with the latest clinical guidelines / -Lifestyle and physical activity and its effects on osteoporosis / -Medication and sports prescription in osteoporosis	NA	NA
14	National Osteoporosis Foundation /Menopause and HT[5] Clinical review of HT in prevention and treatment of osteoporosis [5]	-Primary and secondary osteoporosis and their distinguishing features / -Diagnostic and therapeutic discussion of case studies / scenarios	-Physicians -Nurses -Pharmacists -Technologists -Researchers -Public health professionals and health educators	1 h	-Menopause and osteoporosis / -Premature menopausal osteoporosis / -Prevention and treatment of osteoporosis with hormone therapy (HT) / -Relationship between HT and other treatments for osteoporosis	NA	NA
15	National Osteoporosis Foundation /FLS[6] Certificate Program [11]	-FLS Coordinator / -Learn the basics of FLS / -Apply the principles of FLS care in your practice	-Physicians -Nurses -Healthcare professionals	One week	-Learn the basics of FLS care / -Prevention of secondary fractures / -Management of osteoporosis through medication, exercise and nutrition / -Essentials for using FLS / -Principles of patient evaluation, initiation of treatment, follow-up and post-fracture care	-Synchronized slide/ audio presentations	Receive a certificate of continuing education after completing the sessions
16	National Osteoporosis Foundation /Disuse and Transient Osteoporosis [6]	- Discusses Bone remodeling along with forms of disuse and transient osteoporosis	-Physicians -Nurses -Pharmacists -Technologists -Researchers -Public health professionals and health educators	NA	-Principles of bone reconstruction / -The effect of exercise on BMD[7] / -Effects of smoking cessation on bone / -Different forms of transient osteoporosis / -Effects of pregnancy and lactation on bone	NA	NA

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
17	National Osteoporosis Foundation /Secondary Causes of Osteoporosis [14]	-Causes of secondary osteoporosis -Practical approach to patient treatment in the office	-Physicians -Nurses -Pharmacists -Technologists -Researchers -Public health professionals and health educators	NA	-Primary and secondary osteoporosis and their distinguishing features -Diagnosis and treatment of case studies / scenarios	NA	NA
18	National Osteoporosis Foundation /Identifying Osteoporosis-Related Vertebral Fractures in Primary Care [7]	-Evaluation of osteoporosis -Pathological changes in the spine and the factors affecting it -Differentiation and differentiation of back pain from spinal fractures -Diagnosis of such fractures -Principles of treatment of fractures	-Physicians -Nurses -Pharmacists -Technologists -Researchers -Public health professionals and health educators	NA	-Signs and Symptoms of Acute or "Silent" VCF[8] -Detection and differentiation of VCF from other causes of back pain -VCF risk assessment in patients -Significance, Complications and Mortality in VCF -Diagnosis of secondary causes of VCF other than osteoporosis	NA	NA
19	Royal Osteoporosis Society/ National Training Scheme for Bone Densitometry [12]	Bone densitometry certification for physicians	Clinicians	A 2-day lecture	-Use of DEXA[9] in the effective diagnosis and evaluation of osteoporosis -Record reliable DEXA information for diagnosis and treatment	NA	Mandatory online exam and mandatory submission of work samples
20	Royal Osteoporosis Society/Bone Densitometry Foundation course [15]	NA	NA	NA	-Evaluation and prevention of osteoporosis -Effects, regulations and practical techniques of DEXA	Video-based learning	50-question multiple-choice test, score of 80%, with 3 attempts to the assessment

Table 1 (continued)

NO	Provider center /Name	Course objectives	Target group	Course duration	Course outline/ Course syllabus/ Module syllabus	Educational strategies	Course assessment & evaluation
21	Royal Osteoporosis Society The module is CPD accredited by the RCGP[10]/RCGP Osteoporosis e-Learning Diagnosis and management of osteoporosis [19]	NA	GPs	NA	-Diagnosis, management of osteoporosis and prevention of fractures with, SIGN and NOGG guidelines -Identification of risk groups and risk assessment tools FRAX and QFracture -Assess learners' managerial knowledge of the appropriate time to provide secondary care -Monitoring of patients with osteoporosis and osteopenia and resource management	Case based approach	NA
22	Royal Osteoporosis Society /Osteoporosis resources for primary care (ORPC) [28]	NA	-GPs -Nurses -Other members of the practice team	NA	-Diagnosis and management of osteoporosis -Use guides such as NICE, SIGN and NOGG	NA	NA

[1]The internet-based osteoporosis program
[2]European accreditation council for continuing medical education
[3]Bone research society
[4]Royal college of general practitioners
[5]Hormone therapy
[6]Fracture liaison service
[7]Bone mineral density
[8]Vertebral compression fracture
[9]Dual energy X-Ray absorptiometry (bone scan test)
[10]Royal college of general practitioners

duration of the training, course outline/ course syllabus/ module syllabus, educational strategy and evaluation at the end of the course were extracted (Table1). Studies showed that the Royal Osteoporosis Society and the National Osteoporosis Foundation held the most e-learning on osteoporosis (21.7% and 17.4%, respectively). The general purpose of e-learning classes was to improve skills, and knowledge of the quality of diagnosis, treatment, and care for patients with osteoporosis (Table 1). Additionally, the specific purpose of each training program can be seen in Table 1. The major target group of e-learning included physicians (41%), nurses (36.4%), pharmacists (27.3%), researchers (22.7%) and technologists (18.2%). Others included healthcare professionals (18.2%), public health professionals (18.2%), GPs (13.6%), allied health professionals (13.6%), residents (9.1%), internal medicine specialists (4.5%), radiographers (4.5%), fracture Liaison nurses (4.5%), rheumatologists (4.5%), endocrinologists (4.5%), care of the elderly (4.5%), and orthopedics (4.5%) who are involved in the care team.

According to the study, four studies taught the diagnosis of osteoporosis and, incorporated the guidance from NICE, SIGN, and NOGG [19, 28–30]. Osteoporosis courses with titles such as "Osteoporosis definition and its classifications", "osteoporosis management including drug treatment, adherence, monitoring and non-pharmacological treatments", "Discussing the role of medications and nutrients in bone health, highlights 'at risk' groups of osteoporosis and

FRAX and Fracture risk assessment tools were observed in at least three studies (Table 1).

Also, the osteoporosis courses taught in the two included studies were as follows: applying bone health and osteoporosis resources, bone physiology, and anatomy and how bones respond to stress, demographics of osteoporosis, diagnosis and management of osteoporosis, prevention of fragility fractures, monitoring patients with osteoporosis and osteopenia, introducing clinical practice guidelines, describing the significance of vertebral compression fractures, testing knowledge of participants, and discussing cases.

After reviewing the course outlines, relevant information in ten thematic categories of bone health, osteoporosis definitions and pathophysiology, prevention of osteoporosis, diagnosis of osteoporosis, fractures, non-pharmacological treatments, pharmacological treatments, treatment follow up, postmenopausal considerations and hands-on work was extracted as the final modules for osteoporosis e-learning. Figure 2, the model of osteoporosis e-learning. furthermore, various educational strategies such as digital teaching multimedia, interactive modules, videoconferencing technology, case-based approach, and synchronized slide/audio presentations were used in e-teaching (Table 1). As shown in Table 1, some courses, have an online test score which is determined by taking the certificate, and self-assessment to evaluate students was intended.
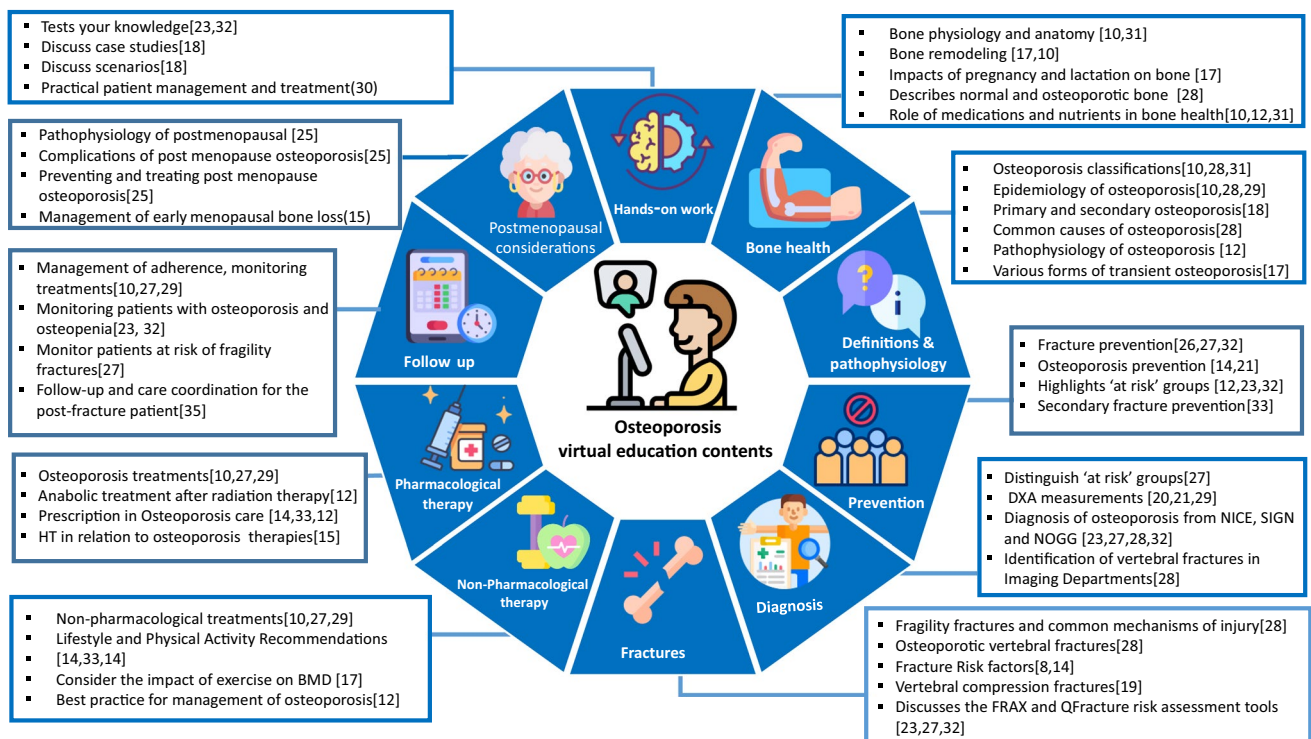

Fig. 2 The model of osteoporosis e-learning

Table 2 Osteoporosis course contents for Physicians

	Modules	Sub-modules
1	Bone measurement and fracture risk assessment	Overview of Osteoporosis
		Bone measurement device: Operating principles of Measurement Device
		Bone measurement device: X-Ray Science, radiation safety
		Clinical evaluation of bone health
		Fracture risk assessment: FRAX and other devices
2	Diagnosis of osteoporosis	Diagnosis of osteoporosis
		Principles of DXA scan interpretation
		Principles of DXA scan reporting
3	Clinical management	Non-Pharmacologic, calcium and vitamin D
		Pharmacologic treatment: Bisphosphonate
		Pharmacologic treatment: HRT, SERMS
		Pharmacologic treatment: PTH and RPTH analogs
		Pharmacologic treatment: Denosumab
		Pharmacologic treatment: Further Pharmacologic Treatment
		Surgical treatment: kyphoplasty and vertebroplasty
		TBS and osteoporosis management
4	Monitoring and follow-up	Monitoring and treatment failure
		Bone turnover markers
		Fracture Liaison Services: Introduction and fundamentals
		Fracture Liaison Services: Implementations
5	Sarcopenia	Introduction and epidemiology
		Management

Course content

In this study, according to the review of the 22 courses provided in studies and websites as well as national guidelines, 45 sub-modules were extracted. The findings were then reviewed by expert panels according to the current needs of our setting. Then, the final modules and sub-modules of osteoporosis courses for GPs were developed and approved for use in our setting (Table 2). It should be noted that according to the expert's opinion, Sarcopenia, as one of the important problems of the musculoskeletal system in the elderly, was added to the content of the e-learning (Table 2).

Discussion

As far as we know, this is the first study to examine e-learning of osteoporosis. Our findings indicate that the e-osteoporosis training was held for a wide range of osteoporosis care teams for prevention, early detection, treatment, follow-up, and rehabilitation. The e-learning course of osteoporosis treatment principles was designed and implemented in response to this need covering the principles of diagnosis, the latest findings on bone

density, control and management of osteoporosis for CPD (Table 2). This ensures that GPs have a general understanding of the disease and how to manage it. Furthermore, the experts recommended adding, the subject of Sarcopenia to the content of the course, as it is considered an important problem of the musculoskeletal system in the elderly.

Jaglal et al. stated that one of the main components of the Ontario Osteoporosis Strategy is training physicians in osteoporosis. The goal of this strategy is to improve the use of clinical guidelines by physicians. To this end, the Ontario College of Family Physicians has designated three evidence-based training modules: osteoporosis in men, fragility and fracture in osteoporosis, and menopausal health. This College also intends to provide e-learning content [28]. Smith et al. believe that healthcare workers should be familiar with osteoporosis and continuously evaluate and planning of interventions in clients. Also, general and comprehensive instructions should be tailored to the patient's specific context [39]. It should be mentioned that knowledge of osteoporosis is still not enough in some fields [24, 25]. Paying attention to the educational content of e-learning and their application in the curriculum of the medical staff, and updating the educational content of osteoporosis will be an effective step in the screening,

prevention, treatment, management, and rehabilitation of people with osteoporosis [8, 9, 40, 41]. In this study, we attempted to provide comprehensive content for osteoporosis management according to the needs of our society divided into five main modules: bone measurement and fracture risk assessment, osteoporosis diagnosis, clinical management, monitoring and follow-up and Sarcopenia and 22 sub-modules (Table 2).

However, due to the importance of osteoporosis and its complications such as fracture, a more comprehensive view of the education of the target group in the field of prevention, early diagnosis, treatment, follow-up, and rehabilitation and the application of appropriate educational materials in their curriculum and ongoing training courses is essential [2, 9, 23, 42, 43]. Course contents should focus on the recognition of sensitive groups, the physiology of bone formation and structure, pathology and lifestyle, and the relationship between bone density, body weight, nutrition, and exercise [4, 44, 45]. The present study showed a wide range of training in the field of osteoporosis management, and with the course titles placed in ten thematic categories (Fig. 2).

Understanding osteoporosis requires understanding the various aspects of the disease and obtaining accurate information and with a focus on specific topics of osteoporosis, which should be included in the training programs of health care professionals [8, 25]. According to Lopez et al. study, providing understandable information, and the cooperation of medical scientific associations are essential to provide quality information [46]. Clynes et al. acknowledged that few people with osteoporosis are treated, and resources should be focused on identifying and treating those at risk of fracture [2, 8]. Fahimfar et al. acknowledge that comprehensive interventions are needed to prevent fractures caused by osteoporosis in the elderly [43, 45]. Sarcopenia is one of the main modules that was not provided in the included studies. However, we included it as one of the main modules in the educational content due to the needs of society and its importance (Table 2).

The development of educational materials on osteoporosis should be appropriate to the weaknesses and deficiencies of healthcare professionals in order to be more effective [8, 9, 47]. Osteoporosis prevention and treatment require the cooperation of various health care professionals other than physicians and GPs, including nurses, physiotherapists, occupational therapists, pharmacists, nuclear medicine technicians, dentists and nutritionists who play an important role in diagnosis, treatment, care and rehabilitation [8, 48–50]. As GPs are at the forefront of early diagnosis and referral of patients, it is important to follow the suitable path to improve osteoporosis management [51]. Thus the principles of osteoporosis management for GPs were compiled in this study. It would have been interesting to look for information on other online courses for doctors that could provide ideas or evidence on the best

way to implement a new course on osteoporosis management. Obviously, in the next steps, specialized training should be developed for each medical specialist providing services in the field of osteoporosis.

Dewan et al. acknowledged that more than half of therapists preferred to use knowledge translation strategies such as online workshops, YouTube videos, webinars, e-reminders, and websites to bridge the knowledge-to-action gap [52]. Increasing access to information, an easy way to update website content, and content distribution, content standardization, and accountability are the benefits of e-learning. On the other hand, learners have control over the time and speed of learning content [20, 21, 25]. The increasing growth of technology and the improvement of the technical knowledge of students have forced teachers to use new, relevant and attractive teaching methods and tools [53–56].

In this study, due to the high workload of GPs and their time constraints, online education was selected as a suitable alternative to face-to-face education for CPD [22]. Web-based educational interventions have shown positive effects on the knowledge, attitude, skill, performance and quality of care of doctors [21, 57]. Alignment of technology, beliefs, practice, and curriculum updates will provide the necessary motivation to advance educational goals [53, 56].

We conducted a comprehensive review of various databases and the Google search engine to ensure that we did not miss anything. Despite the study's strengths, our study had some limitations. Due to the small number of studies, we included all of them and did not conduct a quality appraisal. Additionally, we reviewed records in English language While there were some online osteoporosis courses in other languages. Furthermore, we were unable to answer some of the research questions in the study (NA values in the Table 1), which we attempted to answer by searching other sources and related websites. Thus, it is recommended to carry out further studies regarding the effectiveness of e-learning in transferring knowledge or skills of osteoporosis management by health care providers and patient outcomes, as well as a comparative study of effective methods of e-learning for osteoporosis management. Since the prevention, early diagnosis, treatment and rehabilitation of patients with osteoporosis requires the cooperation of a wide range of specialists, it is recommended to develop specialized and comprehensive online courses for all groups involved in diagnosis, treatment and rehabilitation including gynecologists, endocrinologists and radiologists.

Conclusion

In this study, we reviewed online courses on osteoporosis management using a systematic approach. Our major goals were to increase the therapists' knowledge and confidence in

osteoporosis management, fracture management, and updating information about diagnosis and treatment. The optimal management of osteoporosis requires the development and revision of specialty curriculum from screening to treatment, and aligning training with information technology in order to achieve effective results. Accordingly, we developed modules and sub-modules of an osteoporosis online course for GPs with the aim of early diagnosis and referral of at-risk patients if possible. The content of the approved e-learning contained five main categories, including bone measurement and fracture risk assessment, diagnosis of osteoporosis, clinical management, monitoring and follow-up, and Sarcopenia. This content can be used for osteoporosis e-learning in our setting and the countries with the similar health care condition in the near future.

Abbreviations *CPD*: Continuous Professional Development; *DEXA*: Dual Energy X-Ray Absorptiometry (bone scan test); *FLS*: Fracture Liaison Service; *HT*: Hormone Therapy; *RCGP*: Royal College of General Practitioners; *VCF*: Vertebral Compression Fracture; *FRAX*: Fracture Risk Assessment Tool; *HRT*: Hormone replacement therapy; *SERMs*: Selective estrogen receptor modulators; *PTH*: Parathyroid hormone; *RPTH*: Recombinant parathyroid hormone

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Authors' contributions MA, NF, AO, NM, BL participated in the concept/design, and drafting of the article. RA participated in the search, scientometric analysis, interpretation of data. RN, MA, MS participated in screening, data extraction and verification. RN prepared figures. MN participated in the conducted the review, editing of the article. All authors have read and approved the final manuscript.

Data availability The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The Authors declare that there is no conflict of interest.

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