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Review article

Osteoporosis knowledge assessment and osteoporosis education recommendations in the health professions

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Abstract

A previous systematic review on osteoporosis knowledge published showed that only several studies investigated osteoporosis knowledge in health professionals, and it found that their knowledge was not as adequate and sufficient as it should be. Since then, studies published on osteoporosis knowledge among health professionals have also assessed and found that they still do not have adequate and sufficient osteoporosis knowledge. To increase and improve osteoporosis knowledge among health professionals, recommendations in osteoporosis education in the health professions, including the application of the cognitive load theory, online learning, problem-based learning, practical learning, simulation-based learning, interactive learning, and feedback are covered in order to ensure health professionals can have adequate and sufficient osteoporosis knowledge to best prevent and treat individuals with the disease.

Keywords: Osteoporosis; Knowledge; Education; Health professions

1. Introduction

Osteoporosis is a severe and debilitating bone disease that affects hundreds of millions of individuals worldwide [1]. The disease is medically diagnosed as having reduced bone mineral density that is 2.5 standard deviations below the adult peak mean [2], which decreases bone strength and increases the risk of skeletal fractures, particularly fractures to the hip, spine and wrist, and osteoporosis and osteoporotic fractures significantly reduce the quality of life [3] and increase mortality [4] of those affected.

For the prevention and treatment of osteoporosis, it is vital that health practitioners have adequate osteoporosis knowledge to ensure that they have the ability and skills to effectively treat individuals with this disease. A decade ago, a published systematic review authored by Werner [5] noted the impressive increase in the amount of research studies investigating osteoporosis knowledge in the then-previous decade, and while many studies in the review investigated osteoporosis knowledge in populations considered to be most at risk for the disease, only several studies were conducted assessing the osteoporosis knowledge of health professionals, as Werner [5] noted that "very little attention has been paid to the knowledge of health care professionals involved in the prevention and treatment of osteoporosis". As osteoporosis prevention and treatment requires a multidisciplinary approach from numerous types of health professionals, literature on osteoporosis knowledge found to have investigated health professionals included physicians, nurses, and dietitians, with findings showing that all could have higher levels of osteoporosis knowledge, whether it was general osteoporosis knowledge and/or knowledge of specific osteoporosis topics [5]. Since Werner's [5] review, additional research studies have been conducted in the past decade investigating osteoporosis knowledge of health professionals, which has been studied in both professionals and students in various health fields.

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2. Osteoporosis knowledge assessment in the health professions

2.1. Osteoporosis knowledge in medicine

In the field of medicine, female medical school entrants have modest osteoporosis knowledge with gaps in knowledge of risk factors, preventive behaviors and severity of the disease [6], and medical students know the definition of osteoporosis, but lack knowledge of its complications and preventive measures, as researchers concluded that medical students need more education on risk factors and preventive measures for osteoporosis [7]. Practicing physicians may only have adequate general knowledge of risk factors and preventive strategies of osteoporosis, but limited knowledge in the best and proper treatment strategies for the disease [8].

2.2. Osteoporosis knowledge in nursing

In the field of nursing, nursing students of various grade levels have been shown to have low osteoporosis knowledge, with researchers recommending interventions to increase osteoporosis knowledge [9,10]. Even in senior nursing students, osteoporosis knowledge is inadequate [11–13], with limited knowledge of aspects including risk factors, detection, treatment, and preventive measures. Although osteoporosis education can lead to higher levels of osteoporosis knowledge in nursing students [14], and even though there is some osteoporosis education in the nursing curriculum [15], there is a need for even more osteoporosis education, as osteoporosis knowledge has still been found to be inadequate in senior nursing students, as well as in practitioners in nursing, to treat individuals with the disease. Practitioners in nursing have also been found to have low to only moderate osteoporosis knowledge [16–23], causing recommendations made for increased osteoporosis education in nursing curriculums and continuing education [16,17], as nurses have a desire for more osteoporosis education [22], and have felt their lack of osteoporosis knowledge was a barrier towards giving adequate care [23].

2.3. Osteoporosis knowledge in other health fields and in community health

For other health fields besides medicine and nursing, students studying pharmacy, physical therapy, and dietetics have some osteoporosis knowledge, but levels were still insufficient in terms of general osteoporosis knowledge, particularly knowledge of osteoporosis risk factors and knowledge of exercise and nutrition in relation to osteoporosis and bone health, showing a need for increased osteoporosis education in their respective curricula to better prepare them to work with individuals with osteoporosis in practice after they graduate [13]. Various health professionals working in orthopedics and rehabilitation, such as dietitians, physical therapists and physical therapy assistants, occupational therapists occupational therapy assistants, pharmacists, technologists, among other professionals, generally have low to only moderate osteoporosis knowledge [19], even when working in an orthopedic setting. As physical activity is a key health behavior used for the prevention and treatment of osteoporosis, exercise physiologists also have low to only moderate osteoporosis knowledge, particularly in the areas of disease prevalence, prevention, and nutrition [24]. And as for health professionals who work in community health settings, medical workers in community health service centers were found to have low osteoporosis knowledge [25], and even guardians and caregivers of individuals with osteoporosis have been found to have limited osteoporosis knowledge [26].

2.4. Osteoporosis knowledge conclusion

Consistent to a previous assessment on osteoporosis knowledge of health professionals [5], similar findings from numerous studies thereafter have found that osteoporosis knowledge is still inadequate and insufficient in health professionals. Evidence is firm and conclusive that health professionals who work with and treat individuals with osteoporosis still lack adequate and complete osteoporosis knowledge, regardless of the health field of practice.

Osteoporosis education must start in the curricula for students of these health professions, with continuing education throughout their professional careers. For those who are already health professionals, there is some evidence of moderately effective continuing education for increasing osteoporosis knowledge, at least for physicians. Internet-based lectures on osteoporosis were found to increase osteoporosis knowledge, although patient care was not altered [27]. And although attendance at workshops on osteoporosis medical practices have been associated with higher rates of practice for elderly women and for women and men considered at high risk for the disease, osteoporosis treatment remained suboptimal, particularly for men [28]. Thus, development and designs for better methods and modalities for osteoporosis education is needed for health professionals. As evidence is conclusive that health professionals lack adequate and complete osteoporosis knowledge, focus should be placed on advances in osteoporosis education to increase and improve their osteoporosis knowledge in order to provide individuals with osteoporosis the best treatment and care possible.

3. Osteoporosis education recommendations in the health professions

3.1. Cognitive and learning science theory

To improve osteoporosis knowledge, osteoporosis education should be based on and model off a cognitive and learning science theory developed in order to predict effective learning. One such cognitive and learning science theory, the Cognitive Load Theory (CLT) [29–31], intended to design instruction based on a model human cognitive architecture, is applicable in health profession education due its approach of increasing use of authentic and real-life tasks in learning [32]. In its

practical application in health professions education, the CLT is designed to:

- 1) decrease the manner in which tasks are presented,
- 2) manage the intrinsic nature of learning tasks, and
- 3) optimize actual learning that occurs during learning tasks.

First, to decrease the manner in which tasks are presented designed to assist novice learners to improve towards becoming advanced learners, recommendations include replacing conventional tasks either with worked out examples that include the entire solution that learners can fully study, or with partially work out examples with partial solutions that learners must complete. Another recommendation is to compile multiple sources of information into one single source, such as focusing on a single textbook on osteoporosis treatment and management, or compiling recent peer-reviewed journal articles on osteoporosis treatment and management together as a packet. Second, to manage the intrinsic nature of tasks designed to improve the learning experience, recommendations include replacing a series of conventional tasks with either tasks that initially present isolated elements that work up to full complexity, or tasks that are initially performed in a low-fidelity environment increasing to higher fidelity environments. And third, to optimize actual learning that occurs during learning tasks designed to increase knowledge, recommendations include replacing a series of tasks with another series of tasks with similar, but different, features from a variety of dimensions, and/or replacing fully worked out examples or completed tasks with enhanced ones that contain prompts requesting learners to explain the provided information [32].

For instance, learners can focus first the methods of osteoporosis prevention, such as various weight-bearing physical activity and proper nutrition for healthy individuals, which are relatively simple and easy methods to learn the foundation of how to improve bone health. Once osteoporosis prevention is mastered, learners then move on to more complex and difficult methods to improve and preserve bone health, such as osteoporosis treatment and management for individuals with osteoporosis, which can include contraindicated weight-bearing physical activity and nutritional therapy for safety precautions, use of pharmaceuticals and other medications to preserve bone mineral density, and fall prevention for individuals who are frail with limited balance and mobility. Learners can be given full protocols for osteoporosis treatment and management plans to analyze and memorize, and also be given partial protocols for osteoporosis treatment and management plans that are intentionally incomplete to various extents, and attempt to fill in gaps in order to consider how to provide full, thorough and comprehensive osteoporosis treatment and management plans. In addition, learners can be given case studies of individuals with osteoporosis and study their full osteoporosis treatment and management plans for their particular cases, and then be given case studies of different types of individuals with different cases of osteoporosis, and learn how to alter and adapt osteoporosis treatment and management for different individuals and for different osteoporosis cases. For example, case studies that consider a variety of different variables, such as individuals of both genders, of various ages and ethnicities, factoring physical activity and diet histories, as well as the severity of osteoporosis and history of previous bone fractures, can all help learners consider how to alter and adapt osteoporosis treatment and management appropriately for each individual (see Fig. 1).

With this cognitive and learning science theoretical approach, more osteoporosis knowledge can be acquired, whether a learner is a novice or expert on osteoporosis. Moving forward with this approach, osteoporosis educational methods and techniques to increase osteoporosis knowledge need to be considered for learners. While traditional educational methods are conventional techniques for learning, using traditional educational methods while including non-traditional educational methods, such as online learning, along with problem-based learning, practical learning, simulation-based learning, interactive learning, as well as feedback, have all shown to have advantages in being effective methods of learning and acquiring knowledge and skills to improve practice (see Table 1).

3.2. Online learning

Osteoporosis education can be effective in improving osteoporosis knowledge in both traditional and non-traditional methods, such as the non-traditional but convenient method of online learning. In fact, online and internet-based education and methods are equally as effective as traditional education methods, such as face-to-face learning [33,34]. When developing online learning, important factors to consider are to always maintain focus on the user and learner while taking into consideration the characteristics of the user and learner, the instructional design of the online learning intervention, and the context and technological approach in which the online learning intervention will be used [35]. Online learning is also valuable due to the variety of tools with continuing technological advancements that can enhance knowledge. One such advantage for online learning is that in addition to education that include text, audio and visual methods, advances in online learning include three-dimensional (3D) graphics technology on the World Wide Web, also called Web3D, which can effectively improve medical education for diagnosis of disease, for training in medical procedures, and improve collaboration [36]. For instance, skeletal anatomy, bone biology and osteoporosis pathophysiology can be studied to understand how osteoporosis affects individuals to better treat the disease. In addition, social media tools have been shown to improve knowledge, attitudes and skills while also promoting learner engagement, feedback, and engagement in collaboration and professional development, which has also made this an emerging field that can adapt continuously new technologies for innovative learning [37]. This allows for the creation of learning tools with the aid of photos and videos to share and exchange osteoporosis knowledge, such as effective weight-

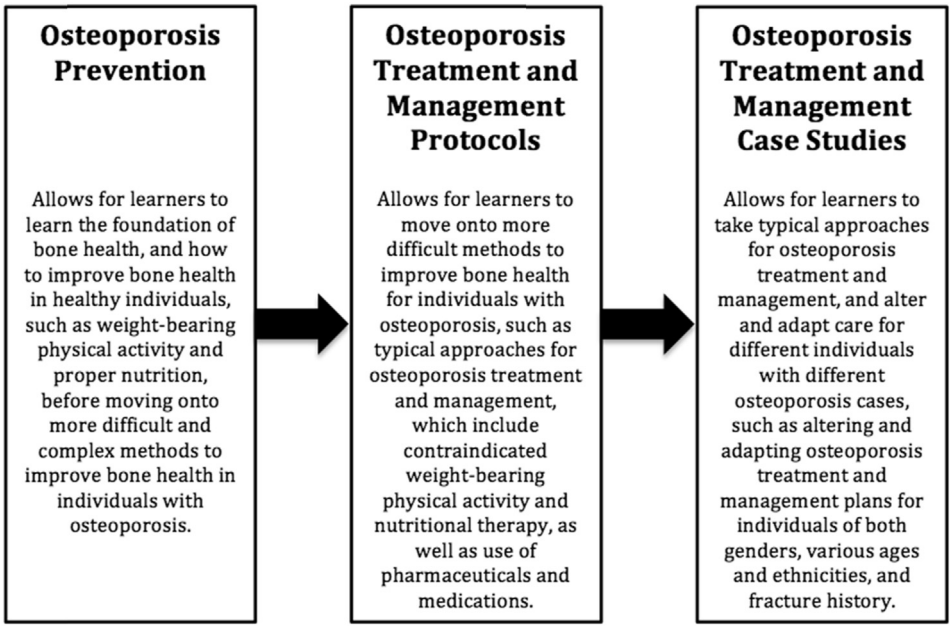

Fig. 1. An application of the cognitive load theory to osteoporosis education.

bearing physical activities, nutrition and foods that promote bone health, latest research of osteoporosis medications, and examples of osteoporosis treatments for a variety of cases. Furthermore, for more effective education in health practice, online learning should be designed using problem-based learning [38].

Table 1
Osteoporosis education methods and advantages.

Methods	Advantages
Online learning	Convenient and equally as effective as face-to-face learning
	Use of 3D graphics technology and social media with photos and videos to enhance learning and sharing
Problem-based learning	Superior for long-term retention of knowledge in comparison to lecture-based learning
	Ability to use videos in addition to text to enhance learning
	Opportunity to apply various case studies of different types of individuals with different cases of osteoporosis
Practical learning	Opportunity to experience health professionals in practice working with real patients in osteoporosis treatment and management
Simulation-based learning	Ability to experience realistic case studies, especially ones that are less common in osteoporosis treatment and management
Interactive learning	Collaboration with various health professions and specialties that work together in osteoporosis management and treatment
	Ability to learn with various educational methods
Feedback	Empirically shown to improve osteoporosis care in regards to clinical performance relative to standards of care
	Leads to lasting improvements in clinical and technical care
	Stimulates curiosity, critical thinking, and desire to learn
	Links existing knowledge to newly acquired knowledge

3.3. Problem-based learning

When acquiring osteoporosis knowledge to improve osteoporosis care, problem-based learning of osteoporosis cases and scenarios are key for effective osteoporosis education. While lecture-based learning is superior for short-term retention for preparation for examinations, problem-based learning is superior for long-term retention, skill development and satisfaction [39]. Both problem-based learning and lecture-based learning can be equally effective in improving knowledge levels, but problem-based learning is more effective in improving performance [40]. Problem-based learning improves performance and some important clinical problem-solving skills are better learned using the problem-based learning method [41]. In addition, problem-based learning can be enhanced with visuals rather than text alone, such as with 3D graphics technology and social media with photos and videos that can be used in online learning. Compared to problem-based learning with text-based cases, problem-based learning with video cases are perceived by learners to enable them to create realistic mental pictures of diseases and disorders, and to see and visualize their patients as real people [42]. For instance, watching videos of different case studies of different individuals who are affected with osteoporosis can help learners empathize with patients and study how to apply appropriate osteoporosis treatment and management for each individual.

3.4. Practical learning

In addition to problem-based learning, practical learning is useful for enhancing osteoporosis knowledge and improving osteoporosis care. Attending conferences, which is a traditional approach for education that involves attending lectures or didactic sessions while networking with minimal or no practical

learning experience, have minimal impact on improving professional practice [43]. However, integrating lecture-based learning with clinical and practical experience and/or residency programs improves clinical practical skills [44]. Practical experiences allows for learners to utilize knowledge and apply it in clinical settings, providing an opportunity to not only learn and understand knowledge, but also be able to use and apply that knowledge for practice, improvement and refinement. While problem-based learning and studying videos of case studies of individuals with osteoporosis is an effective learning method, although practical learning may not be as convenient for learners and patients as it requires scheduled times for meeting, it is valuable in osteoporosis education as it allows for learners to truly experience real-life osteoporosis treatment and management by working along practicing health professionals and with real individuals who are affected with and being treated for the disease.

3.5. Simulation-based learning

Practical learning experiences involve preventing, treating and managing of osteoporosis with real individuals with or at risk of osteoporosis, but practice with the creation of fictitious but realistic osteoporosis cases and scenarios also have value. Fictitious but realistic cases and scenarios, also known as simulators or simulations in simulation-based learning, can reproduce a wide variety of clinical conditions (cases and scenarios) for practice to master techniques and skills [45], and simulations and simulation-based education have been shown to be effective in education [46], while also improving skills related to the treatment and management of complex critical diseases [47], which can include osteoporosis. While osteoporosis is more common in older women over 50 years of age and of Caucasian and Asian ethnicity, simulation-based training allows for the opportunity to learn how to treat and manage osteoporosis in less common but still important demographics, such as osteoporosis cases in men, of individuals under 50 years of age and of various of ages, and of individuals of various ethnic backgrounds. Simulation-based education can be deliberate practice integrated into a curriculum that allows for the opportunity for feedback, skill acquisition and maintenance, mastery learning, and transfer to practice [48]. Simulation-based education provides both a learner-centered environment and a clinical setting without the risk of harm to a live patient, and learners have higher levels of enthusiasm with increased clinical competency due to the integration of learning concepts with the development and performance of clinical skills. Furthermore, while problem-based has shown to be an effective method of education, simulation-based learning may be an even more effective method of education due to learners being more engaged while learning from a variety of pathways, such as auditory, visual and tactile pathways [49].

3.6. Interactive learning

Didactic sessions do not appear to effectively change clinical performance, but interactive and mixed educational sessions show effectiveness in practice [50]. This is particularly important in osteoporosis education, as osteoporosis might be the most multidisciplinary treatment and management disease in health care, as there are no single profession and specialty dedicated specifically to osteoporosis, but there is a collaboration of multiple professions and specialties that work together to treat and manage the disease, which increases the value of interactive learning. Various professions include, but are not limited to, physicians, nurses, physical therapists, dietitians, and pharmacists, and various specialties include family health/medicine, community health/medicine, internal medicine, physical medicine and rehabilitation, geriatrics, orthopedics, endocrinology, gynecology, rheumatology, and pediatrics. The most effective educational methods are the ones that are most interactive, such as didactic presentations along with workshops rather than didactic presentations alone, and are more effective when there are multiple interventions, especially occurring over an extended period of time [51]. The most effective educational strategies used multiple interventions, including exchange of printed materials with images, and two-way communications with educators who were respected and knowledgeable health professionals [52]. For interactive education in small groups, students find the most effective way to learn is in a non-threatening group atmosphere with pedagogical materials that promote independent thinking with problem-solving of clinical relevance, along with the opportunities to ask the instructor questions for feedback and work together as a team in order to solve problems in problem-based learning [53]. And interactive learning methods that are detailed academically and involve feedback are the most effective in changing care and patient outcomes [54].

3.7. Feedback

Feedback has been noted numerous times due to its important role in education and learning. In fact, Weng, Hess, Lynn and Lipner [55] found that osteoporosis care improves with feedback of clinical performance relative to standards of care. In order for feedback to be effective, it must be provided by instructors that have medical knowledge, clinical skills and evidence-based practice, quality improvement, interdisciplinary teamwork and systems, and professionalism [56]. As the treatment and management of osteoporosis is multidisciplinary, multiple professions may provide expert instructor feedback for different aspects of osteoporosis treatment and management. For example, feedback for proper prescription and progression of weight-bearing physical activity may be provided by physical therapists and exercise physiologists, feedback for osteogenic foods and nutritional therapy for osteoporosis may be provided by dietitians, and feedback for the various and numerous medications used to treat and manage osteoporosis and related conditions may be provided by pharmacists.

In addition, these instructors must understand that the goal for effective teaching is effective learning, advocacy for and passion for education, while being respectful, kind and ethical.

They must also stimulate curiosity, critical thinking and desire to learn, while acknowledging one's own limitations, and display communication skills such as questioning, listening and responding effectively [57]. And simply providing information is not as effective as verbal feedback from an expert instructor, as it can lead to lasting improvements in clinical and technical skills performance [58]. When offering feedback, it is more effective to first ask the learner to evaluate his/her own performance prior to giving feedback, and then give specific examples to illustrate an expert's own observations and suggest specific strategies for how the student can improve performance [59]. The instructor should give praise for aspects completed well, while also giving constructive feedback on aspects that need improvement [57]. Feedback should be facilitative rather than directive, it should focus on the task and not the learner and allow the learner to reflect while in action [60]. Reflection and reflective practice, such as learning from one's own experience and understanding/integrating one's personal beliefs, attitudes and values, can be effective in linking existing knowledge while also acquiring new knowledge [61].

4. Summary

Increased and improved osteoporosis education is clearly needed in the respected curriculums for students in the health professions, and in the continuing education for health professionals. Osteoporosis education should be based on and modeled off of a cognitive and learning science theory, such as the Cognitive Load Theory, in order to improve osteoporosis knowledge for novice to advanced learners. Osteoporosis education methods should include various methods, such as online learning, problem-based learning, simulation-based learning, and interactive learning. In addition, expert feedback is vital for learners to enhance their osteoporosis knowledge to improve their osteoporosis care when preventing, treating, and managing the disease.

Future considerations can include the frequency of osteoporosis education, as approximately two-third to three-fourth of knowledge learned is attained after 1 year, and below half of knowledge learned is attained after the following year [62], osteoporosis education should be continuous and implemented often, on an annual basis or perhaps even more frequently. As osteoporosis education has traditionally focused on medical and clinical topics, it is also important to consider the inclusion of managerial, social and personal skill education [63], in order to provide a more well-rounded education. This can also take into consideration the inclusion emotional intelligence, which is the ability to receive, use, understand and manage emotions [64], which can improve interpersonal and communication skills and help in transferring osteoporosis knowledge from the health professional to the patient [65]. And to ensure learners acquire adequate and sufficient osteoporosis knowledge, assessment methods during osteoporosis education to explicitly target important competencies both during and after learning sessions with the use of examinations [66], can also be taken in consideration.

With advances in osteoporosis education, in addition to the implementation of future considerations, osteoporosis knowledge in health professionals can be increased and improved to a level necessary to ensure that they are adequately prepared to properly and most effectively prevent, treat and manage the disease that affects millions of individuals around the world.

Conflicts of interest

The author declares that there is no conflict of interest with the publication of this manuscript.

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