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REVIEW

Effectiveness of patient education for patients with osteoporosis: a systematic review

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Abstract

Summary In this systematic review, the effects of osteoporosis patient education were examined. All studies found an effect on physical function, but for the other themes, the results were inconclusive. The findings indicate a need for further research in this topic.

Introduction Osteoporosis is a chronic disease with serious consequences for the individual and major societal costs. With the aim of fracture prevention, many countries offer osteoporosis patient education. The objectives were to examine the effects and mediators of osteoporosis patient education and describe the characteristics of studies with and without an effect. Though, none of the included studies reported mediators, and therefore, we could not examine that.

Methods Six databases were searched in October 2020. Two researchers independently conducted title and abstract screening as well as full-text review. Records were included if participants had osteoporosis, and the patient education was group-based, face-to-face, and addressed two or more aspects, e.g., diet, medication, and exercise. The Cochrane Collaboration tools were used for risk of bias assessment. Finally, data were extracted into a standardized form and presented narratively.

Results In total, 2934 records were identified, and 13 studies met the inclusion criteria. All six studies examining the effects of patient education on physical function demonstrated improvements. In addition, one out of two RCT studies and one non-randomized study reported improved psychological wellbeing. Just one out of five RCT studies showed improvements regarding physical discomfort and disability. Effects on health-related quality of life, adherence and persistence, and knowledge of osteoporosis were inconclusive.

Conclusion There is limited evidence for the effectiveness of osteoporosis patient education. There is a need for high-quality randomized controlled trials, which should describe the characteristics of the interventions and examine the mechanisms of osteoporosis patient education.

PROSPERO registration number CRD42020211930

Keywords Bone health education · Group education · Osteoporosis · Osteoporotic fracture · Patient education

Introduction

Osteoporosis is a chronic disease that causes reduced density and quality of the bones and thereby increases the risk of fractures. It is estimated that 27.6 million people in Europe have osteoporosis [1]. The disease and the related fractures have high societal costs (€37.4 billion in Europe) [1] as well as individual consequences, such as decrease in quality of life [2], change in self-image, and dependency on others [3].

Osteoporosis is normally treated by ensuring sufficient levels of calcium and vitamin D in the diet, preventing immobilization by staying physically active, and initiating pharmacological treatment [4, 5]. Therefore, patients with osteoporosis may benefit from patient education covering these themes. The aim of osteoporosis patient education is to increase participants' understanding, skills, and confidence [4] as well as medication compliance and persistence [4, 6], and thereby prevent fractures. During osteoporosis patient education, the participants should get training and information, but patient education should not just provide information, it should also enable behavioral change if participants

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have the opportunity to interact with health professionals and gain social and psychological support from a group of participants [4, 6].

Many countries worldwide offer osteoporosis patient education, for instance Canada [7], Australia [8, 9], the USA [10, 11], and Denmark [12]. Typically, these programs include information about osteoporosis and fracture prevention [7, 8, 10–12], including advise on diet [9–12], medication [7, 9, 10, 12], and pain [9, 12] as well as physical exercise [12]. These programs are group-based and delivered face-to-face [7, 8, 10–12] for instance 2 h once a week for 4 weeks [9].

A previous systematic review by Jensen et al. [13] investigated the effectiveness of osteoporosis patient education and found that patient education can increase the participants' health-related quality of life, physical activity, psychosocial functioning, and adherence to pharmacological and non-pharmacological treatment [13]. However, other systematic reviews have reported inconsistent findings [14–17]. Besides that, research on this topic is sparce [6], which is also indicated by the low number of studies identified in previous systematic reviews, for instance 7 [15] and 13 studies [14].

Prior systematic reviews are limited to assess the effects of osteoporosis patient education [13–15, 18, 19], and have not evaluated the mediators though which the effects occur. Though, to understand the effects of patient education, it is crucial to examine the processes [20]. Furthermore, the reviews have focused on predefined outcomes [14–17, 19], but to examine the full potential of osteoporosis patient education, it is essential to look at all possible outcomes and not limit the search to specific outcomes. Finally, to fully understand effective patient education interventions, it is important to describe the characteristics of the studies so that comparisons between studies and implementation of effective interventions can be made.

To update and advance knowledge based on the existing evidence, we conducted a systematic review focused on two objectives: (1) to extract and synthesize all reported quantitative data regarding the effects and mediators of patient education for patients with osteoporosis and (2) to describe the characteristics of studies with and without an effect. Though, none of the included studies examined mediators, and therefore, we were unable to complete that goal.

Methods

The systematic review was registered in PROSPERO prior to the formal screening of search results (registration number CRD42020211930). The reporting was guided by the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) [21].

Inclusion criteria

The search was guided by the following research question: What are the effects and mediators of osteoporosis patient education? The inclusion criteria were defined by the PICO tool, which outlines the Population, Intervention, Comparison, and Outcome [22]:

- Population: Patients with osteoporosis (clinically diagnosed or self-reported) or patients with a bone mineral density (BMD) T-score of ≤ -2.5 or a fragility fracture of the columna or hip. More than half of the participants had to meet this criterion.
- Intervention: Programs that address a variety of aspects (two or more), e.g., knowledge of osteoporosis, diet, medication, pain, fracture prevention, and exercise. In addition, classes should be group-based (three participants or more) and be conducted face-to-face.
- Comparisons: No intervention, treatment as usual, or another modified intervention.
- Outcome: All potential outcomes and mediators examined via mediation models.

Both randomized controlled trials, non-randomized studies, and observational studies were included. To be able to better compare results, qualitative studies were excluded.

Literature search

The search strategy was planned in close collaboration with a research librarian from the University of Southern Denmark. The following databases were searched: Embase, CINAHL, Web of Science, Cochrane Library, Educational Resources Information Center (ERIC), and National Rehabilitation Information Center (REHABDATA). Grey literature was searched in ProQuest Dissertations & Theses Global, Scopus (conference proceedings only), and on relevant institutions' websites. Moreover, reference lists of included studies and other relevant studies, such as systematic reviews, were searched.

The following search terms were used in all databases: osteoporosis, osteoporotic fracture, patient education, group education, osteoporosis education, bone health education, education intervention, patient teaching. The search was based on subject headings and free text searches (see Online Resource 1 for the search string in each database).

All databases were searched in October 2020. Records were included if they were written in English, Swedish, Norwegian, or Danish. In addition, we included records published from 1980 until the time of the search. All

published material was included, for instance letters, editorials, conference abstracts, dissertations, and book chapters.

Selection of studies

After running searches in all databases, the records were imported to EndNote and thereafter Covidence. In this process, duplicates were removed.

Title and abstract screening was conducted by two researchers independently (a total of three researchers were involved). Disagreements were solved via consensus (Cohens's Kappa for agreement: 0.49). Thereafter, full-text review was conducted by two researchers, also independently (Cohens's Kappa for agreement: 0.65).

For some records [9, 23, 24], it was not clear whether the studies fulfilled the inclusion criteria. In these cases, we wrote to the corresponding authors. If we did not receive a reply, we excluded the study.

Some records could not be accessed immediately and had to be ordered. If this material was not delivered within 1 month, the records were excluded (an overview of the records is provided in Online Resource 2).

For some studies, a full-text article was not available, only a meeting abstract or conference abstract (23 records corresponding to 18 studies). These were excluded after searching relevant databases, where we searched on the title as well as each of the involved authors.

Risk of bias assessment

The included studies underwent risk of bias assessment. The assessment was conducted by two researchers independently (a total of three researchers were involved). Disagreements were solved via consensus. To ensure consistency in the quality assessments, meetings were held on an ongoing basis, focusing on inter-rater reliability.

The Cochrane Collaboration tools for risk of bias assessment were used. These were RoB 2.0 and RoB 2.0 CRT for randomized controlled trials and ROBINS-1 for non-randomized studies of interventions [25, 26]. These tools focus on the studies' internal validity. The results of the risk of bias assessment are shown in Fig. 1.

Three studies [27–29] were observational studies with no comparison groups. For these studies, the risk of bias was measured according to four domains, which we selected from RoB 2 and ROBINS-1 and modified as appropriate. The domains were "bias due to confounding," "bias in selection of participants into the study," "bias due to missing outcome data," and "bias in measurement of the outcome." All studies were assessed as being at high risk of bias, mainly due to a lack of control for confounding. Furthermore, the study by Harrison et al. reported a large dropout at the 4-year follow-up [27]. The study by Peel et al. lacked information about the selection of participants and dropout [28]. Finally, the study by Billington et al. included only posttest and no pretest [29].

Data extraction and synthesis

The data extraction was carried out by one researcher with supervision from another researcher.

We extracted the data using a standardized data extraction form. It included study design, participant characteristics, description of intervention, mediators (Table 1), and results (Table 2 and Online Resource 3). The primary analysis was reported for all studies. If available, the difference between groups was reported and otherwise, the scores for each group were reported. Between-group comparisons were reported for all studies and in addition intra-group comparisons were reported for the study by Grahn Kronhed et al. [30], as the control group received educational sessions in accordance with our inclusion criteria. Mediators were reported if a mediation model was used for examining mechanisms for the relationship between an independent variable and a dependent variable.

For five studies, data were extracted from two full-text articles because they both contained important information.

For nine studies [27, 28, 31, 32, 34, 35, 37, 42, 44], the information for extraction could not be found in the articles, and therefore, the corresponding author was contacted if possible. In case of no reply or no email address (for six studies), this information is missing.

The extracted data were synthesized and presented narratively. If studies reporting on the same outcome showed different results, the characteristics of each study were examined to highlight what may be important for the effectiveness of the intervention. In the synthesis, the risk of bias was taken into account, meaning that studies with low risk of bias were weighted higher than studies with high risk of bias. The studies with no comparison group were given minimal weight.

Results

In total, 2934 records were identified (Fig. 2). After 738 duplicates were removed, 2196 records underwent title and abstract screening. In this process, 2060 records were excluded. The remaining 136 records were subject to full-text review and thereby 117 records were excluded. After adding records from reference harvesting, a total of 22 records were included, corresponding to 13 studies.

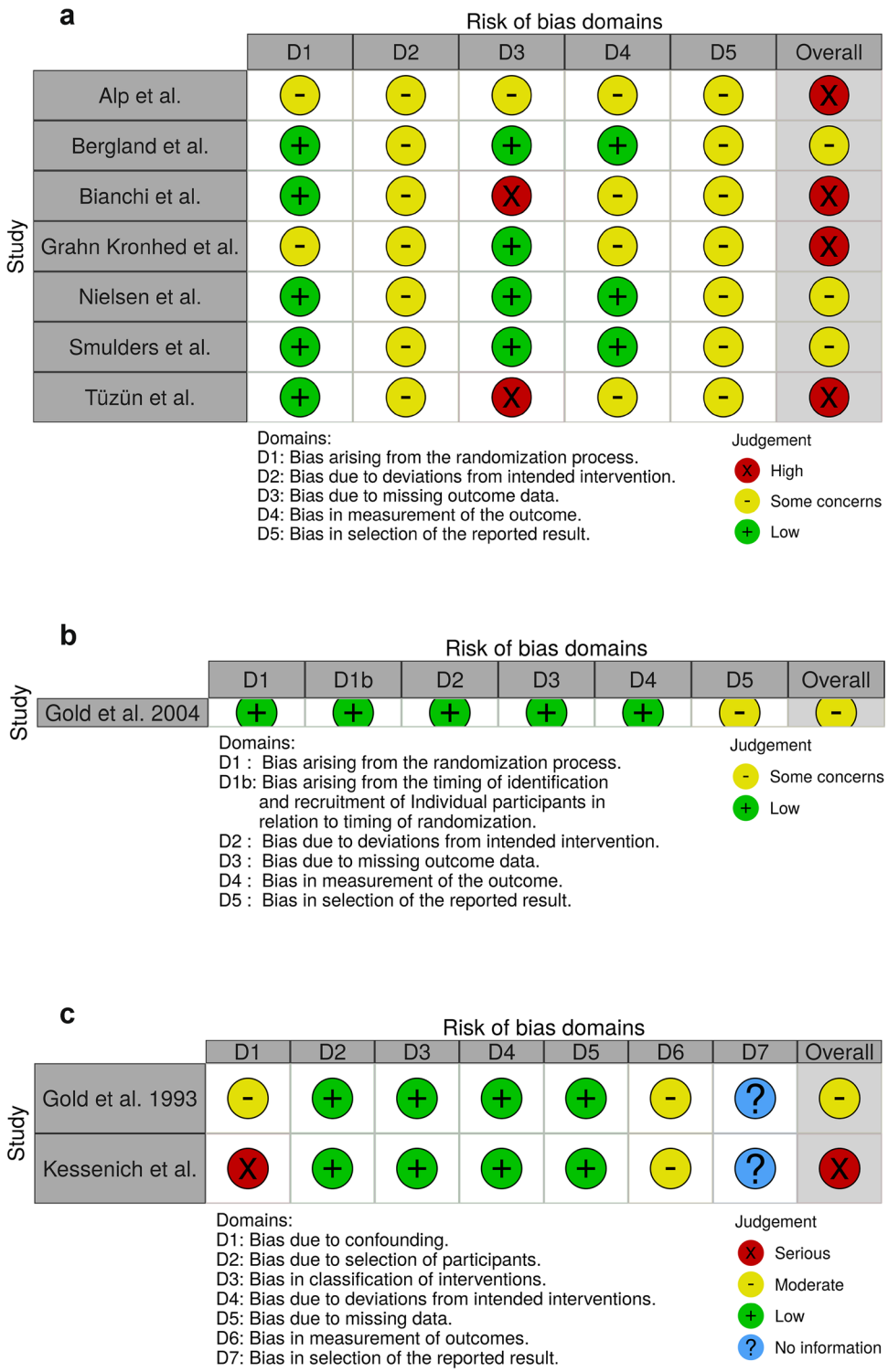

Fig. 1 Risk of bias assessment using RoB 2.0 (**a**), RoB 2.0 CRT (**b**), and ROBINS-1 (**c**). Note: The figures are made with the Risk-of-bias VISualization (robvis) [45]

Characteristics of studies and interventions

The 13 included studies were published between 1989 and 2020. The studies were conducted in eight different countries: the USA ($n=4$), Canada ($n=2$), Turkey ($n=2$), Italy ($n=1$), Sweden ($n=1$), Norway ($n=1$), Denmark ($n=1$), and the Netherlands ($n=1$). The studies varied in size from 20 to 448 participants. The time from baseline to follow-up varied from 4 weeks to 4 years.

The majority of the participants were women; four studies included both women and men where the percentage of men ranged from 5 to 13%. Ages varied from 62 to 81 years. Five

Table 1 Characteristics of 13 included studies

Study	Study type	Number of participants	Characteristics of participants (gender, fractures, mean/median age [range], country)	Time to follow-up	Mediator(s)
Alp et al. (2007) [31]	Randomized controlled trial	Total = 50 IG = 25 CG = 25	Women with and without prior fracture Mean age 66 ± 12 years Turkey	5 weeks (end of intervention) and 6 months	None
Bergland et al. (2011) [32, 33]	Randomized controlled trial	Total = 89 IG = 42 CG = 47	Women with vertebral fracture Mean age 71.4 [60–83] years Norway	3 months (end of intervention), and 12 months	None
Bianchi et al. (2015) [34]	Randomized controlled trial	Total = 334 CG1 = 113 IG2 = 110 IG3 = 111	Women with and without prior fracture Mean age 63.8 years[a] Italy	12 months	None
Billington et al. (2020) [29]	Observational study, posttest, no comparison group	Total = 85	Women with and without prior fracture Median age 62 [58–67] years Canada	There is just a posttest	None
Gold et al. (1993) [35, 36]	Non-randomized study, pretest and posttest	Total = 103 IG = 43 CG = 60	Women (n = 91) and men (n = 12) with vertebral fracture[a] Mean age 67 years (SD = 9) North Carolina	60 days	None
Gold et al. (2004) [37]	Group randomized, modified cross-over trial	Total = 185 IG = 94 CG = 91	Women with vertebral fracture Mean age 81.1 years North Carolina	3 months, 6 months (end of intervention for IG), 9 months, 12 months (end of intervention for CG)	None
Grahn Kronhed et al. (2020) [30]	Randomized controlled trial	Total = 20 IG = 10 CG = 10	Women (n = 19) and men (n = 1) with vertebral fracture Mean age 71.8 years Sweden	10 weeks (end of intervention)	None
Harrison et al. (1993) [27, 38]	Observational study, pretest and posttest, no comparison group	Total = 139 (78 at 4-year follow-up)	Participants with and without prior fracture (no information on gender)[b] Mean age 64 years (SD = 8) Canada	4 years	None
Kessenich et al. (2000) [39]	Non-randomized study, pretest and posttest	Total = 50 IG = 25 CG = 25	Women with vertebral fracture Mean age 70.4 years Florida	8 weeks (end of intervention)	None

Table 1 (continued)

Nielsen et al. (2010) [40, 41]	Randomized controlled trial	Total = 300 IG = 150 CG = 150	Women (n = 267) and men (n = 33) with and without prior fractures Median age 64 [45–81] years Denmark	3, 12, and 24 months	None
Peel et al. (2001) [28]	Observational study, pretest and posttest, no comparison group	Total = participants from the 3 most recent classes (number not mentioned)[b]	Women (no information on prior fracture)[b] Mean age 66 [43–76] years Alabama	4 weeks (end of intervention)	None
Smulders et al. (2010) [42, 43]	Randomized controlled trial	Total = 96 IG = 50 CG = 46	Women (n = 90) and men (n = 6) (no information on prior fracture)[b] Mean age 71.0 ± 4.7 years The Netherlands	5.5 weeks (end of intervention) and 1 year	None
Tüzün et al. (2013) [44]	Randomized controlled trial	Total = 448 IG = 226 CG = 222	Women (no information on prior fracture)[b] Mean age 62.4 ± 7.7 years Turkey	3, 6, 9, and 12 months	None

Study	**Content of intervention**	**Comparison group**	**Size of class**	**Length of program**
Alp et al. (2007) [31]	Self-management program "Choices for better bone health": Sessions: 1. Calcium and vitamin D, 2. Medicine, 3. Negative feelings, social roles, and pain, 4. Exercise and risk of fall, 5. Development of personal plan	The control group was told to maintain current lifestyle	Not described[b]	5 weeks, once a week for 50 min
Bergland et al. (2011) [32, 33]	Exercise sessions: 10 min warm-up (aerobic exercises), 40 min sequence of exercises (e.g., walking forwards, sideways, and backwards, climbing steps, training balance), 10 min stretching Information session: Body awareness and ergonomic advice for everyday life (e.g., lifting and carrying)	The control group was asked to maintain current lifestyle	Not described[b]	Exercise sessions: 3 months, twice a week for 1 h Information session: 3 h
Bianchi et al. (2015) [34]	Group 2 received different information and reminders (2 booklets, memo stickers, a small alarm clock, and advice on how to use the reminders) Group 3 received the same as group 2 plus 4 phone calls and 4 educational meetings Topics[a]: Importance of always remembering to regularly take the prescribed therapy; difficulties in following the instructions about therapy; problems related to therapy (e.g., interference with life habits); clarity and completeness of received information; how to read the drug information leaflet; need for further clarification about therapy; doubts about therapy; side effects of osteoporosis drugs	The control group (group 1) was managed according to usual care	4–6 persons	4 phone calls and 4 educational meetings over 12 months

Table 1 (continued)

Billington et al. (2020) [29]	Self-management Consult Program (SCP): 2-h group education regarding osteoporosis and lifestyle interventions 2-h group medical appointment with education on osteoporosis, risk of fracture, consequences of fragility fracture, and benefits and risks of different medications. Besides that, the patients calculated their individual risk of fracture	No comparison group	5–10 persons	2×2 h
Gold et al. (1993) [35, 36]	Duke University Preventive and Therapeutic Program for Osteoporosis (DUPATPO): Content: Exercise instructions, nutritional counseling, and educational sessions about osteoporosis and medication. In the end, the patients are given 1. individualized training program, 2. dietary recommendations, and if needed 3. medications and nutritional supplements	The control group received usual care	4 persons or fewer	4 days
Gold et al. (2004) [37]	Phase 1: Exercise classes: Focused on physical difficulties caused by vertebral fractures: Trunk weakness, trunk flexibility, and keeping erect posture when sitting and standing Coping classes: Focused on psychological difficulties caused by vertebral fractures: Anxiety, depression, and stress Phase 2: Self-maintenance of the exercise and coping skills	Phase 1: General information about, e.g., hypertension, diabetes mellitus, breast cancer, and urinary incontinence Phase 2: Exercise and coping classes	Approx. 10 persons[a]	Phase 1: Exercise classes: 6 months, 3 times a week for 45 min Coping classes: 6 months, twice a week for 45 min Phase 2: Self-maintenance: 6 months
Grahn Kronhed et al. (2020) [30]	Theory sessions: Topics: 1. Physical activity, 2. Diagnosis and medication, 3. Mindfulness and medical yoga, 4. Spinal orthosis and stable shoes, 5. Diet, 6. Balance and training, 7. The osteoporosis patient association, 8. Ergonomic advice for everyday life, 9. Pain Modified medical yoga and mindfulness sessions: 30 min medical yoga training, 30 min mindfulness training	The control group received the theory sessions	10–18 persons	10 weeks, once a week for 2 h
Harrison et al. (1993) [27, 38]	Program for Rehabilitation of Osteoporotic Patients (PRO): Educational sessions: Topics: Diet, exercise, home safety, and medication Social activities: Not described in more detail Exercise classes: 20 min strength training, 30 min aerobic training In the beginning all patients joined the supervised classes, but after 1–2 months some patients made the exercises at home	No comparison group	Not described[b]	The educational sessions are monthly (not described in detail)[b] The supervised exercise classes were held twice a week (not described in detail)[b]
Kessenich et al. (2000) [39]	Support group: Topics: Osteoporosis, medication, diet, humor therapy, pain, Tai Chi, herbal therapy, physical therapy Weekly telephone calls: Encouragement and reminder of the next meeting	The control group received usual care	25 persons	8 weeks, once a week for 90 min

Table 1 (continued)

Nielsen et al. (2010) [40, 41]	Group education: Topics: Development of osteoporosis, medication, diet, fall prevention, fractures and pain, osteoporosis in everyday life, instructions in physical exercises Reinforcement program: A computerized telephone call where the patients are contacted and asked about their wellbeing	The control group was asked to continue their usual activities and prescribed therapy. If the patients had previous vertebral or hip fractures, they were given the opportunity to participate in physiotherapist-led exercise classes	8–12 persons	4 weeks, 3–4 h a week After 1 year a 2-h brush-up course Reinforcement program: 4 months, once a month
Peel et al. (2001) [28]	"Tone Your Bones": 15 min: Lecture on osteoporosis, calcium and Vitamin D, medication, exercise 15 min: Warm-up 30 min: Education and practice in movements where participants keep a neutral spine posture 20 min: Exercises focusing on muscle strength, posture, and balance 10 min: Cooldown	No comparison group	10–12 persons	4 weeks, twice a week for 90 min
Smulders et al. (2010) [42, 43]	The Nijmegen Falls Prevention Program (NFPP): Education about, e.g., osteoporosis, medication, exercise, fall prevention. In addition, obstacle courses, training in fall techniques, walking exercises, weight-bearing exercises, correction of gait abnormalities	The control group received usual care	10 persons	5.5 weeks, twice a week for approx. 2 h
Tüzün et al. (2013) [44]	"Starter Training Kit": Medication guides and booklets about, e.g., osteoporosis, exercise, nutrition, patient rights 4 telephone calls: Reminder to read the booklets and attend the educational meetings 4 educational meetings: Topics: Osteoporosis, exercise, nutrition, patient rights	The control group received the "Starter Training Kit"	10 persons	4 telephone calls and 4 educational meetings over 12 months

IG intervention group, *CG* comparison group.

[a]Data are from personal communication with one of the affiliated authors.

[b]No email address in the article or no response from the affiliated author.

Table 2 Outcome measurements and results for six themes

Theme	Study	Outcome (assessment)	Result
Health-related quality of life	Alp et al. (2007) [31]	SF-36	6 months follow-up: Difference between groups in all domains
	Bergland et al. (2011) [32]	GHQ-20; QUALEFFO-41	3 months follow-up: Difference between groups regarding improvement in GHQ-20 total score and QUALEFFO-41 mental function 12 months follow-up: Difference between groups regarding improvement in QUALEFFO-41 total score, mental function, physical function, and pain
	Grahn Kronhed et al. (2020) [30]	EQ-5D-3L; RAND-36; QUALEFFO-41	No differences between groups Improvement for IG regarding RAND-36 social function and QUALEFFO-41 social function
	Kessenich et al. (2000) [39]	Cantril Ladder; SF-36; OQLQ	No differences between groups
	Peel et al. (2001) [28]	SF-36	Improvement in the mental component scale from baseline to follow-up
	Smulders et al. (2010) [42]	QUALEFFO-41	No differences between groups
	Tüzün et al. (2013) [44]	QUALEFFO-41	No differences between groups
Adherence and persistence	Bianchi et al. (2015) [34]	Adherence to therapy (5 methods: doctors' assessment, questionnaires, patients' diaries, examination of drug boxes, and bone turnover markers); persistence with therapy (also 5 methods); starting vs. not starting treatment	Difference between groups regarding the number of women starting vs. not starting therapy
	Billington et al. (2020) [29]	Initiation of therapy (participants' indication)	No statistical test
	Nielsen et al. (2010) [40]	Adherence to therapy (short questionnaire)	3, 12, and 24 months follow-up: Difference between groups regarding adherence rate
	Tüzün et al. (2013) [44]	Treatment compliance and persistence (participants' indication)	No differences between groups
Knowledge of osteoporosis	Alp et al. (2007) [31]	Understanding the purpose and benefits of medications (simple questionnaire)	No statistical test
	Nielsen et al. (2010) [40]	PAVIOS (questionnaire)	3, 12, and 24 months follow-up: Difference between groups regarding improvement in osteoporosis knowledge
	Tüzün et al. (2013) [44]	Basic knowledge on osteoporosis (questionnaire)	No differences between groups

Table 2 (continued)

Theme	Study	Outcome (assessment)	Result
Psychological wellbeing	Gold et al. (1993) [35]	Stress symptoms (The Short Psychiatric Evaluation Scale); self-esteem (the 10-item Rosenberg Self-Esteem scale); psychiatric symptoms (SCL-90-R)	Difference between groups regarding improvement in stress symptoms and psychiatric symptoms (Global Severity Index, somatization, obsessive\compulsive, and anxiety dimensions)
	Gold et al. (2004) [37]	Psychological symptoms (the Global Severity Index of SCL-90-R)	After phase 1: Difference between groups regarding improvement in psychological symptoms After phase 2: Improvement for CG and maintenance for IG
	Grahn Kronhed et al. (2020) [30]	Sleep quality (self-constructed questionnaire with a symmetric Likert scale); perceived present stress (also self-constructed questionnaire); coping (the Patient Enablement Instrument)	No differences between groups Improvement for IG regarding sleep quality and perceived present stress
Physical function	Alp et al. (2007) [31]	Balance (Sensitized Romberg Test); functional status (Timed Sit to Stand); joining regular physical activities (simple questionnaire); making personal plans for better bone health (simple questionnaire); new falls (simple questionnaire)	6 months follow-up: Difference between groups regarding balance and functional status No statistical test for the other outcomes
	Bergland et al. (2011) [32]	Mobility (Maximum Walking Speed (MWS) and Timed Up and Go (TUG)); balance (the Functional Reach test)	3 months follow-up: Difference between groups regarding mobility (MWS and TUG) and balance 12 months follow-up: Difference between groups regarding mobility (MWS and TUG)
	Olsen & Bergland (2014) [33]	Fear of falling (the Falls Efficacy Scale—International)	3 and 12 months follow-up: Difference between groups regarding fear of falling
	Gold et al. (2004) [37]	Trunk extension strength (the exercise equipment B-200 Isostation)	After phase 1: Difference between groups regarding improvement in trunk extension strength After phase 2: Improvement for CG but worsening for IG
	Harrison et al. (1993) [27]	Fitness (exercise tolerance test on treadmill)	Improvement in fitness from baseline to follow-up
	Peel et al. (2001) [28]	Isometric strength of scapilar adductors and hip abductors (hand-held dynamometer); balance (the Functional Reach test and the Tandem Romberg test); height, maximum height, and overhead arm reach	Improvement in all outcomes from baseline to follow-up
	Smulders et al. (2010) [42]	Fall rate (participants' registration); balance confidence (short version of the ABC Scale); activity level (LASA Physical Activity Questionnaire and pedometer)	1-year follow-up: Difference between groups regarding fall rate and balance confidence

Table 2 (continued)

Theme	Study	Outcome (assessment)	Result
Physical discomfort and disability	Alp et al. (2007) [31]	Pain intensity (Visual Analogue Scale)	6 months follow-up: Difference between groups regarding pain intensity
	Gold et al. (2004) [37]	Pain with activities (the pain subscale of the Functional Status Index)	After phase 1: No differences between groups After phase 2: No changes for neither CG nor IG
	Grahn Kronhed et al. (2020) [30]	Pain (The Numeric Rating Scale)	No differences neither between groups nor within groups
	Harrison et al. (1993) [27]	Bone mass (neutron activation analysis); back pain (clinical assessment); vertebral and non-vertebral fractures	Increase in bone mass from baseline to follow-up
	Smulders et al. (2010) [42]	BMD at the hips and lower back (DXA)	No differences between groups
	Tüzün et al. (2013) [44]	Vertebral and non-vertebral fractures	1-year follow-up: No differences between groups

IG intervention group, *CG* comparison group, *SF-36* the 36-item Short-Form Health Survey of the Medical Outcomes Study, *GHQ-20* the 20-item General Health Questionnaire, *QUALEFFO-41* Quality of Life Questionnaire of the European Foundation for Osteoporosis, *EQ-5D-3L* the generic EuroQol five dimensions with three levels, *RAND-36* the RAND 36-Item Health Survey, *Cantril Ladder* the 10-step Cantril Ladder, *OQLQ* Osteoporosis Quality of Life Questionnaire, *PAVIOS* Patienters Viden om OSteoporose, *SCL-90-R* the Hopkins Symptom Checklist 90 – Revised, *DXA* Dual-energy X-ray Absorptiometry.

studies included participants with and without prior fractures, and five studies included participants with vertebral fractures. For three studies, there was no information about prior fractures.

The content of the osteoporosis patient education intervention varied widely. All interventions included educational sessions about, e.g., osteoporosis, nutrition, or medication. Moreover, seven interventions included exercises that varied from simple instructions practiced in groups [35] to supervised exercise programs including warm-up, weight-bearing and/or aerobic exercises, and cooldown [32]. The size of the classes ranged from 4 to 25 persons, and the duration varied from two meetings of 2 h to three meetings a week for 6 months. A summary of the included studies is provided in Table 1.

The included studies reported on 25 different outcomes (Table 2 and Online Resource 3) categorized into six themes: health-related quality of life, adherence and persistence, knowledge of osteoporosis, psychological wellbeing, physical function, and physical discomfort and disability, which are presented in the following. There was variation among the included studies concerning the scales and instruments used for measuring the outcomes (Table 2 and Online Resource 3). Many studies used self-reported measures, e.g., for health-related quality of life, while other studies used performance tests, e.g., for measuring mobility [32] or strength [37].

Health-related quality of life

Seven studies [28, 30–32, 39, 42, 44] measured the effect of osteoporosis patient education on health-related quality of life. In four studies, it was the primary outcome.

Two RCT studies [31, 32] found a change in health-related quality of life when comparing the intervention group with the control group. Bergland et al. found that the change in GHQ-20 total score was larger in the intervention group compared to the control group at 3-month follow-up (effect size 0.4). At the 12-month follow-up, the difference was apparent for QUALEFFO-41 total score, QUALEFFO-41 mental function, QUALEFFO-41 physical function, and QUALEFFO-41 pain (effect size 0.3, 0.4, 0.3, and 0.5, respectively) [32]. Alp et al. found a change in all domains of SF-36 when the intervention group was compared with the control group at 6-month follow-up [31].

Moreover, Peel et al. found in an observational study with no comparison group an increase in the mental component scale of SF-36 from baseline to follow-up. However, no change was found in the physical component scale [28].

Smulders et al. found no time by group interaction effect regarding QUALEFFO-41 total score [42]. Likewise, Tüzün et al. found no difference between the

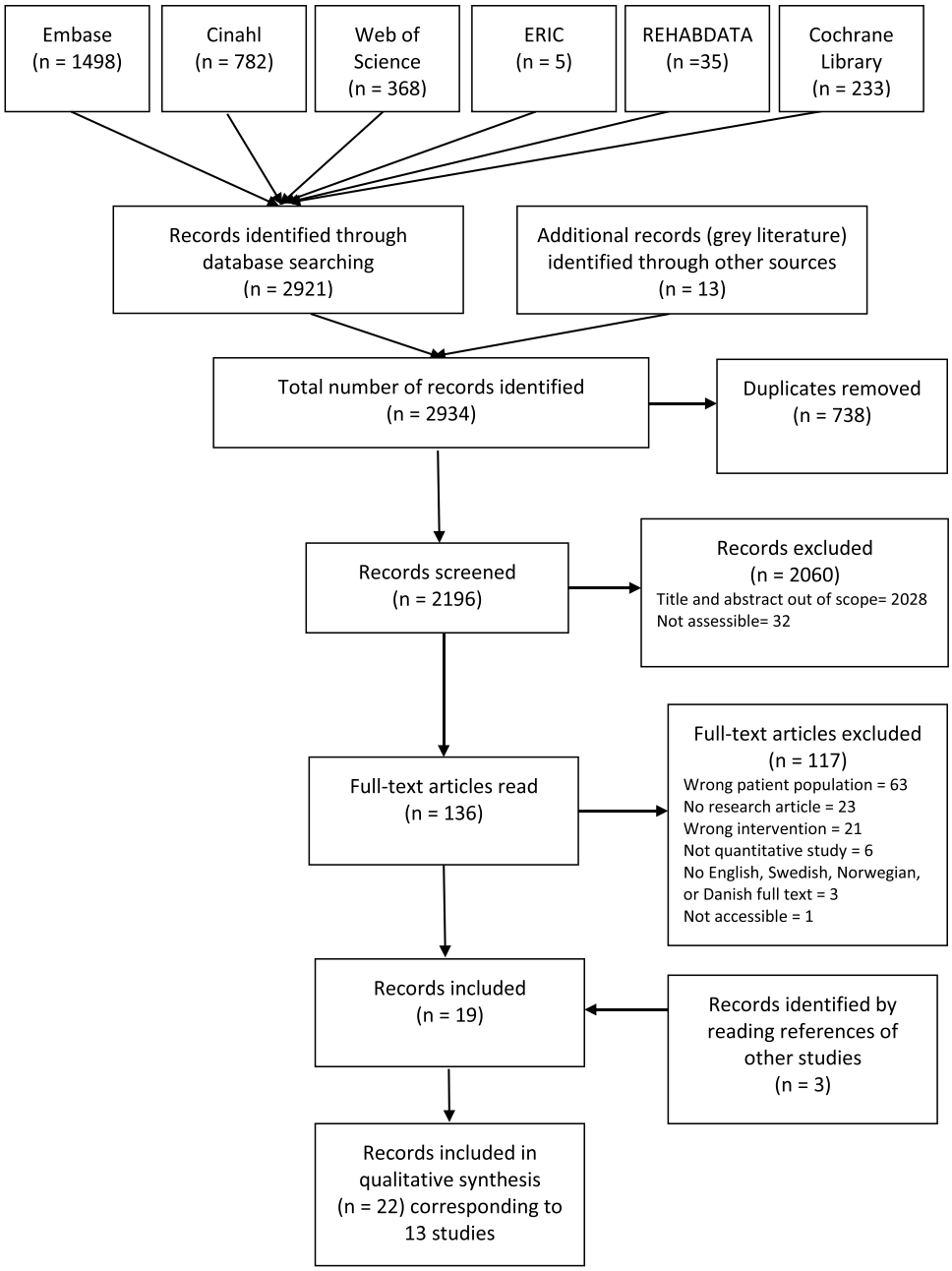

Fig. 2 Flowchart for inclusion of records

QUALEFFO-41 scores of the intervention group and the control group at 1-year follow-up [44]. Grahn Kronhed et al. measured health-related quality of life with three instruments but found no difference when comparing the intervention group with the control group at the 10-week follow-up [30]. Also, the study by Kessenich et al. measured health-related quality of life with three instruments but found no differences in the change of scores between the two groups [39]; however, this is a non-randomized study assessed as being at serious risk of bias.

Characteristics of studies and summary of health-related quality of life

The two RCT studies that did find an effect on health-related quality of life had relatively long follow-up periods on 12 [32] and 6 months [31]. The four studies that did not find effects both had short and long follow-up periods, from 8 weeks to 12 months.

The characteristics of the participants varied slightly, as the studies by Bergland et al. and Alp et al. only included female participants [31, 32]. Tüzün et al. and Kessenich

et al. also included female participants [39, 44], whereas Smulders et al. and Grahn Kronhed et al. included both female and male participants [30, 42].

In conclusion, two out of five RCT studies found an effect of osteoporosis patient education on health-related quality of life and there is no clear pattern of the characteristics in studies with or without an effect. One non-randomized study with a pretest and posttest did not find an effect on health-related quality of life.

Adherence and persistence

A total of four studies [29, 34, 40, 44] examined the effect of osteoporosis patient education on adherence and persistence regarding treatment. In two studies, it was the primary outcome.

In the study by Nielsen et al., the adherence rate was higher in the intervention group (92%) compared to the control group (80%) at 2-year follow-up [40]. Furthermore, Bianchi et al. found that the number of women starting vs. not starting therapy varied between groups. However, no difference between groups with regard to adherence and persistence was found [34]. Likewise, Tüzün et al. found no difference between the intervention group and the control group regarding treatment compliance and persistence [44].

The aim of the last study by Billington et al. is not straightforward for this systematic review, and it is an observational study with no comparison group and no baseline measurements. However, it is mentioned that after the educational sessions, 27% of participants planned to initiate therapy, 46% planned to decline therapy, and 27% remained undecided [29].

Characteristics of studies and summary of adherence and persistence

Nielsen et al. is the only study showing an effect on adherence and it had a longer follow-up period (2 years) than Bianchi et al. and Tüzün et al. (1 year). In the study by Nielsen et al., the intervention was more intensive, as the group education was mainly conducted within 4 weeks compared to the studies by Bianchi et al. and Tüzün et al., where the interventions were spread out on 1 year. Finally, the study by Nielsen et al. included both men and women [40], whereas the studies by Bianchi et al. and Tüzün et al. only included women [34, 44].

In sum, one RCT study found an effect on adherence, whereas two RCT studies did not find an effect on adherence, persistence, or compliance. The study that found an effect had a better risk of bias assessment than the studies that did not.

Knowledge of osteoporosis

Three studies [31, 40, 44] measured the impact of a patient education intervention on the patients' knowledge of osteoporosis. In one study it was the primary outcome.

Nielsen et al. found an improvement in the osteoporosis knowledge score when comparing the intervention group (2 points improvement) and the control group (0 points improvement) at 2-year follow-up [40]. In the study by Tüzün et al., there was no difference between the groups at 1-year follow-up [44].

In the study by Alp et al., the impact of the intervention on knowledge of osteoporosis was not statistically tested. However, they reported that 92% of the participants in the intervention group understood the purpose and benefits of medications and dietary calcium intake compared to 30% in the control group [31].

Characteristics of studies and summary of knowledge of osteoporosis

The study by Nielsen et al. included both men and women, and the intervention was more intensive than the intervention in the study by Tüzün et al. In the study by Tüzün et al., the control group was given a "starter training kit" with various booklets [44], whereas in the study by Nielsen et al., the control group was asked to continue their usual activities [40].

In conclusion, one out of two RCT studies that reported a statistical test regarding knowledge of osteoporosis found a difference between groups. There were some differences in the characteristics of the two studies. The study that found an effect had the best risk of bias assessment.

Psychological wellbeing

Three studies [30, 35, 37] evaluated the effect of osteoporosis patient education on psychological wellbeing. In two studies, it was the primary outcome.

The study by Gold et al. (2004) is a cross-over study and they found that after phase 1 the change score regarding psychological symptoms was greater in the intervention group than in the control group. After phase 2, in which the control group participated in the exercise and coping classes, their psychological symptoms improved compared to their change during phase 1 [37]. Likewise, Gold et al. (1993) found a group by time interaction regarding overall psychological symptoms as well as differences in the somatization, obsessive\compulsive, and anxiety dimensions [35]. Though, this study is a non-randomized study assessed as being at moderate risk of bias.

Self-esteem was also measured in the study by Gold et al. (1993) but group by time interactions were not found [35].

Grahn Kronhed et al. measured sleep quality but found no differences between groups at follow-up. Furthermore, they examined how participants coped with their illness but no differences between the groups were found at follow-up [30].

Stress symptoms were examined in two studies. Gold et al. (1993) found a group by time interaction effect [35]. However, Grahn Kronhed et al. did not find any between-group difference in perceived present stress at follow-up [30].

Characteristics of studies and summary of psychological wellbeing

The two studies examining stress symptoms varied in size (20 [30] and 103 [35] persons). Also, the study by Gold et al. (1993) included smaller groups (four persons or fewer) than the study by Grahn Kronhed et al. (10–18 persons). Furthermore, the length of the programs varied from 4 days [35] to 10 weeks [30] as well as the content.

In sum, one out of two RCT studies found an effect on psychological wellbeing. The study that did find an effect has a better risk of bias assessment than the study that did not. Moreover, one non-randomized study with a pretest and posttest found an effect on psychological wellbeing.

Physical function

Six studies [27, 28, 31, 32, 37, 42] measured the effect of patient education on physical function. In four studies, some aspects of physical function were defined as the primary outcome.

All six studies found an effect of patient education on one or more aspects of physical function. One study showed a better result in terms of mobility in the intervention group compared to the control group at both the 3- and 12-month follow-ups when measuring "Maximum Walking Speed" (effect size 0.5 and 0.4, respectively) and "Timed Up and Go" (effect size 0.2 and 0.3, respectively) [32] and fear of falling [33]. Smulders et al. examined fall rate, which was lower for the intervention group than the control group during 1-year follow-up (fall IRR 0.61) [42].

Three studies examined balance or balance confidence. Bergland et al. found a difference between the intervention group and the control group regarding balance measured by "Functional Reach" at 3-month follow-up (effect size 0.6) [32]. Alp et al. measured balance using the Sensitized Romberg Test and found a difference between groups at 6-month follow-up [31]. Smulders et al. measured balance confidence using the short version of the ABC Scale and found a time by group interaction effect [42].

Smulders et al. also examined activity level measured by a pedometer and the LASA Physical Activity Questionnaire but found no time by group interaction effects [42].

Gold et al. (2004) evaluated trunk extension strength with a standard protocol for the exercise equipment B-200 Isostation and found a difference in change between groups after phase 1 (difference in foot pounds 10.68). After phase 2, the control group improved their trunk extension strength relative to their change in phase 1 [37].

Alp et al. tested functional status by "Timed Sit to Stand" and found a difference in mean percent changes between groups at 6-month follow-up (− 29.9 and 7.8 for the intervention group and the control group, respectively). Finally, Alp et al. measured new falls, plans for preventing trauma, and physical activity with a simple questionnaire but no statistical test was carried out.

The studies by Peel et al. and Harrison et al. were observational studies with no comparison group. Harrison et al. found a difference from baseline to the 4-year follow-up on fitness measured by an exercise tolerance test [27]. Peel et al. found a change from baseline to the 4-week follow-up regarding isometric strength, balance, height, maximum height, and overhead arm reach [28].

Characteristics of studies and summary of physical function

The four RCT studies that show an effect on physical function varied in size from 50 to 185 participants. The mean age varied from 66 to 81 years. The length of the programs varied from 5 weeks to 6 months with varying content; however, all studies except Alp et al. included both educational and exercise sessions, which were supervised [31, 32, 37, 42]. The study by Alp et al. was judged to be at higher risk of bias than the other three studies.

In conclusion, all six studies, which included four RCT studies, found an effect of osteoporosis patient education on physical function.

Physical discomfort and disability

Six studies [27, 30, 31, 37, 42, 44] examined some aspect of physical discomfort and disability. In two studies, it was defined as the primary outcome.

Tüzün et al. did not find a difference between the intervention group and the control group regarding vertebral or non-vertebral fractures at 1-year follow-up [44].

Smulders et al. measured BMD at the hips and lower back but did not find a time by group interaction effect after 1 year [42].

At 6-month follow-up, Alp et al. found a difference in mean change scores of pain intensity (0–10) when comparing the two groups (− 3.4 and 1.6 for the intervention group and the control group, respectively) [31]. Though, Grahn Kronhed et al. did not find a difference either between groups or within groups regarding median values for present pain, pain in the past week, or worst pain [30]. Likewise,

Gold et al. (2004) did not find a difference in change scores of pain with activities when comparing the intervention group and the control group after phase 1 [37].

The observational study with no comparison group by Harrison et al. examined bone mass, fractures, and back pain. They found an increase in bone mass from baseline to follow-up but no change regarding fractures and back pain [27].

Characteristics of studies and summary of physical discomfort and disability

The study by Alp et al. differs, as it included participants with and without prior fracture, whereas the studies by Grahn Kronhed et al. and Gold et al. (2004) included participants with vertebral fractures. The mean age in the study by Alp et al. was 66, whereas it was 72 [30] and 81 [37] in the two other studies. Furthermore, the study by Alp et al. consisted of educational sessions, whereas the two other studies comprised both educational and exercise sessions. The intervention in the study by Alp et al. was shorter and the control group was told to maintain their current lifestyle [31] while the control group in the two other studies participated in some kind of information sessions [30, 37].

In sum, one out of five RCT studies found an effect on some aspect of physical discomfort and disability. This study was judged to be at high risk of bias.

Discussion

This systematic review examined the effects of osteoporosis patient education though it was also our intention to examine mediators. All studies examining physical function found an effect. For the other themes (health-related quality of life, adherence and persistence, knowledge of osteoporosis, psychological wellbeing, and physical discomfort and disability), the results were inconclusive. However, there was a tendency of improved psychological wellbeing. On the other hand, there seems to be no effect on physical discomfort and disability.

Regarding the characteristics of the studies with or without an effect, it is difficult to draw conclusions due to the small number of studies and poor risk of bias assessments. The characteristics of the studies examining physical function vary greatly except that three out of four RCT studies conducted interventions with a combination of educational and exercise sessions. In these cases, the exercise sessions were supervised by a physical therapist [32, 37] or physical and occupational therapists [42]. It seems reasonable that the intervention should include supervised exercise sessions to improve physical function. The two observational studies [27, 28] used interventions with supervised exercise sessions as well. In the study by Harrison et al., half of the participants chose to make the exercises at home after 1 to 2 months. This study found no differences regarding fitness between those joining supervised exercise sessions and those making exercises at home [27]; this may be because all participants began with supervised classes and thereby learned how to perform the exercises correctly.

We found that adherence to medication and knowledge of osteoporosis could be improved if the intervention was more intensive and included both sexes. This indicates that the composition of patient education influences both behavioral change and knowledge level, as the program in which participants meet mainly 3–4 h a week for 4 weeks [40] is more effectful than programs in which they meet four times during 1 year [34, 44]. In addition, the inclusion of both men and women seems to be important, but from these findings, we cannot provide explanations. Maybe the combination creates more space for learning, maybe men are more susceptible, or maybe a third explanation is needed. The study that did find an effect had a longer follow-up period and a better risk of bias assessment than the studies that did not find an effect, which strengthens the results.

Finally, the characteristics of an effective intervention to reduce pain included a combination of patients with and without fractures, a lower mean age, and a shorter intervention period consisting of educational sessions only. From these findings, age and fractures may influence the ability to reduce pain but because of the diversity of the studies it is difficult to explain the results. The composition of patient education also varies, and therefore, it is difficult to say whether it is the characteristics of the patients or the composition of patient education that makes the difference. Lack of effect could to some extent be explained by the fact that the control group in the non-effective studies also participated in some information sessions.

In general, our findings correspond to prior systematic reviews, e.g., by Jensen et al., who examined the effectiveness of multifaceted osteoporosis group education [13]. Though, regarding health-related quality of life and knowledge of osteoporosis, our results are more inconclusive. This inconsistency may be because we included a larger number of studies. Moreover, Jensen et al. included one study [8] that did not meet our inclusion criteria regarding the population.

Morfeld et al. did not make conclusive statements though they found, e.g., improved knowledge of osteoporosis in more than half of the studies and improved physical activity in less than half [14]. This contrasts with our findings which may be because our inclusion criteria were narrower. Giangregorio et al. did not make definitive conclusions regarding the effect of exercise interventions [15]. Their finding corresponds to our findings except for physical function which

may be because Giangregorio et al. focused on interventions with exercise sessions.

Hiligsmann et al. and Gleeson et al. examined the effect of various interventions to improve adherence and persistence with osteoporosis medication. Hiligsmann et al. conclude that the efficacy is uncertain [16], and Gleeson et al. conclude that few studies found an effect [17], which is in accordance with our findings regarding adherence and persistence.

Implications of findings

Due to the small number of studies, this review has not resulted in stronger conclusions regarding the effectiveness of osteoporosis patient education than prior reviews. Because of the limitations in the evidence, we are unable to recommend widespread implementation of patient education in this area. Nevertheless, this systematic review contributes with important knowledge, as we found an effect of osteoporosis patient education on physical function. Here physical function covers different outcomes and therefore these findings suggest that patient education may improve different aspects of physical function. Small to moderate effects were found on "Maximum Walking Speed," i.e., seconds spent walking 20 m and "Timed Up and Go," i.e., seconds spent raising from a chair, walking 3 m, and going back [32]. Besides that, mean changes in "Timed Sit to Stand," i.e., seconds spent raising from a chair 10 times, had improved for the intervention group (from 30 to 21 s), but worsened for the control group (from 28 to 30 s) [31]. Mobility measured by performance tests like these has shown to be a predictor of better physical functioning [46] and fewer functional limitations and disablement [47], and therefore, these findings are of importance for the patients in the long term. In this systematic review, we also found improvements in balance [31, 32, 42] and fall rate [42], which may influence on the occurrence of fractures. As fractures have big consequences for the individual [48] as well as the societal costs [1], these findings are of relevance in more perspectives.

We also found tendencies for psychological wellbeing and physical discomfort and disability as well as characteristics of studies with and without an effect such as sex, age, and the duration of the intervention. For the other themes, the results were inconclusive and therefore there is a need for more research evaluating the effects of osteoporosis patient education.

Limitations and strengths

An important strength of this systematic review is the inclusion of all types of studies, namely randomized studies, non-randomized studies, and observational studies, which provided us with a larger number of studies. Even though this influenced the quality of the studies, we did gain more information about the potential effects and mediators.

This systematic review also has some limitations regarding the inclusion criteria. We included studies evaluating osteoporosis patient education that address a variety of aspects (two or more), such as knowledge of osteoporosis, diet, medication, pain, fracture prevention, and exercise lessons. This delimitation was applied in order to reflect how osteoporosis patient education is typically constructed, and therefore, this limitation is also a strength. In addition, we expected that the programs should have some weight in order to detect an effect.

We included studies evaluating programs conducted in groups and face-to-face. According to the WHO, osteoporosis patient education should give the participants the opportunity to express their expectations and discuss them with a health professional. Moreover, the participants should have the chance to gain support from a group of participants [4]. Because of these recommendations, we delimitated our inclusion criteria.

Furthermore, we included studies with participants who had osteoporosis or who had a BMD T-score of ≤ -2.5 or a fragility fracture of the columna or hip, which is in accordance with the Danish diagnostic criteria. This delimitation ensured a homogenous group of participants, which would also simplify the development of evidence-based programs.

Our search was restricted to records published from 1980 until the time of the search and this has more implications. Firstly, because of the long period of time, the studies use a wide range of scales and instruments. For instance, a total of 7 instruments were used to measure health-related quality of life. This makes it difficult to compare the findings and therefore we could have limited the time period and thereby limited the variability in scales and instruments. Secondly, in the time period from 1980 until 2020, new medications for osteoporosis became available. This may explain why the theme adherence and persistence was only addressed in newer studies. If we had limited the time period, there would have been a more equal base for the studies to examine effects of osteoporosis patient education.

We included quantitative studies and excluded qualitative studies. Though, to identify mechanisms of osteoporosis patient education, we could also have included qualitative studies, e.g., process evaluations, which could have added valuable findings.

Finally, we included records written in English, Swedish, Norwegian, or Danish. This potentially causes a bias as we might have missed studies written in other languages.

The risk of bias assessment also has the limitation that the majority of the included studies were given a poor risk of bias assessment. This is due to a few reasons. Firstly, as the intervention consists of patient education, blinding of participants and personnel is not possible. Secondly, we

used a rather strict cutoff of 5% for the acceptable amount of missing data and finally, we did not have a statistical analysis plan for any of the studies. We could have softened our judgements here and consequently obtained better risk of bias assessments.

Another limitation concerns the selection of studies. We had to order some material and if we did not receive it within 1 month, we excluded it. This was the case for 32 records during the title and abstract screening and one record during the full-text review. This decision may have affected the results as we might have missed eligible studies. Though, as the total number of identified records was 2934, then the 33 records excluded here is a small part.

Furthermore, for some studies, we could not find a full-text article but only an abstract, and these studies were excluded as well. This was the case for 23 records, corresponding to 18 studies. There is a potential risk that we missed an eligible study because of this.

Finally, we did not conduct a meta-analysis as the included studies examine very different outcomes, and because of the small number of included studies there would equally be a small number of studies examining the same outcome.

Limitations of included studies

There are several limitations of the studies included in this systematic review, which future research should overcome.

Firstly, many of the included studies had a short follow-up period (1 year or less); only one study had a 4-year follow-up and one had a 2-year follow-up. Therefore, we are not able to draw conclusions regarding the effects of osteoporosis patient education on a longer term.

Another limitation concerns the lack of descriptions of characteristics of the participants and interventions. This makes it difficult to compare the characteristics of the studies with and without an effect, which would also make it difficult to design evidence-based programs based on the results.

Finally, none of the included studies examined mediators of the associations and therefore we have no knowledge of what mechanisms cause the effects. To get an understanding of the full potential of patient education, it is essential to outline a causal chain or program theory [49] that describes the immediate and longer term outcomes and thereby examines the intervention mechanisms. However, in the included studies, the results are discussed, and possible explanations are provided. For instance, Gold et al. explain the reduction in psychological symptoms with the fact that participants were given the opportunity to share experiences with each other [35, 37]. Explanations like these are valuable for understanding the results, but they do not fully examine the mechanisms of osteoporosis patient education, e.g., via mediation models. However, some studies [27, 40] examined associations between outcomes, which contributes with assumptions about the mechanisms. For instance, Nielsen et al. found no association between adherence to medication and knowledge of osteoporosis and therefore concluded that adherence is not just a matter of transferring knowledge to the patient [40]. In this case, knowledge of osteoporosis could be considered a mediator, which contributes with valuable information for understanding the processes of osteoporosis patient education.

Conclusions

Previous studies have indicated that osteoporosis patients may benefit from patient education. However, research on this topic is sparce and inconsistent. In this systematic review, we found that patient education has an effect on physical function. For the other themes, the results were inclusive and for mediators, there were no data.

As there are some shortcomings in the included studies, there is potential for further research on this topic. There is a need for studies that evaluate osteoporosis patient education in well-conducted randomized controlled trials with long follow-up periods. It is crucial that they describe the characteristics of the studies so that they can be compared and implemented in practice. Moreover, they should examine the mediators and thereby contribute to a wider understanding of the mechanisms of osteoporosis patient education.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00198-021-06226-5.

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Availability of data and material The search string is provided in Online Resource 1. Records excluded due to time limit are provided in Online Resource 2, and tables with outcome measurements and results are in Online Resource 3.

Code availability Not applicable.

Declarations

Conflicts of interest Mette Friberg Hitz has received grants from Orkla Care, Denmark, UCB, Ellab Fond, and Amgen and received personal payment in relation to lectures and advisory board meetings. Mette Rubæk, Teresa Holmberg, Bodil Marie Thuesen Schønwandt, and Susan Andersen declare that they have no conflict of interest.

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