Strong, Steady and Straight: UK consensus statement on physical activity and exercise for osteoporosis.

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SUPPLEMENTARY MATERIAL

CONTENTS:

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Appendix I: Discussion guides for Stakeholder Groups

1. Question guide for stakeholder groups with patients

- Introductions, what are your experiences of osteoporosis and fracture?
- What does the term exercise mean to you? How is it different from physical activity?
- Do you think exercise is important in osteoporosis?
- Have any of you started a new exercise since your fracture/since you have been diagnosed. Tell us about this
- What would make you feel more confident to undertake exercise
- What are your concerns relating to exercise

Show Strong Straight & Steady powerpoint

- What do you think about the headings strong, straight and steady and what do you think they mean?
- Does this include the important questions?
- Do you think advice should be different for different groups of people? If so – who?

2. Question guide for stakeholder groups with health and exercise professionals

- Introductions
- What are you experiences of discussing exercise with patients with OP and fracture?
- What uncertainties do you have about advising patients about exercise?
- What does the term exercise mean to you – or your patients. How is it different from physical activity

Show Strong Straight & Steady powerpoint

- What do you think about the headings strong, straight and steady and what do you think they mean?
- Does this include the important questions?
- Do you think advice should be different for different groups of people? If so – who?
- Who should have an assessment before exercise and who should do the assessment?

Appendix II: Online Survey

The National Osteoporosis Society is working with experts in the field to create a UK Expert Statement on how exercise and physical activity can help to improve bone strength - what exercise is needed and what is safe. Although information and advice is available, we know there are uncertainties and unanswered questions that need addressing so that people with osteoporosis can get the information they need.

If you are either a health professional, working with people with osteoporosis, or you have the condition or are at risk, we would love to hear your views.

1. Do you have a questions or issues about exercise and osteoporosis that you would like the experts to address in their Expert Statement ? Please explain in the box below.
   An example might be ' Will brisk walking strengthen the bones in my back' or 'Is jogging helpful and safe to strengthen my hip bones, if I've got low bone density'

2. Are you interested in this subject as : (please tick all that apply)

- ☐ a health professional
- ☐ someone with low bone density - not in the osteoporosis range someone with osteoporosis (diagnosed on a bone density scan) someone with osteoporosis who has had one spinal fracture someone who has had more than one spinal fracture
- ☐ someone with osteoporosis - you aren't sure if you've had spinal fractures someone with osteoporosis who has broken other bones after a simple fall someone 'at risk' of fractures and advised to take an osteoporosis drug treatment someone with risk factors for osteoporosis
- ☐ someone who isn't very mobile or used to exercise
- ☐ Other (please specify)

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3. The charity plans to produce new and improved information resources on exercise and osteoporosis. Would you, or your patients, use the following :

- ☐ printed material, such as fact sheets, that could be ordered or downloaded from our website video clips on our website
- ☐ a DVD
- ☐ Other (please specify)

4. How old are you (please only answer Q 4- 6 if you are interested for yourself) :

- ☐ 0 - 35
- ☐ 36 - 45
- ☐ 46 - 55
- ☐ 56 - 65
- ☐ 66 - 75
- ☐ 76 - 85
- ☐ 86 or over

5. What gender are you :

- ☐ male
- ☐ female
- ☐ other

6. How would you describe your ethnic origin :

- ☐ White
- ☐ Asian or Asian British (including Chinese)
- ☐ Black/African/Caribbean/Black British
- ☐ Mixed/multiple ethnic groups
- ☐ I prefer not to say
- ☐ Other (please specify)

Thank you for your help.

We cannot provide you will a personal reply from this survey. If you would like to discuss your own situation or get more information please contact our helpline 0808 800 0035 or nurses@nos.org.uk . If you would like more information about the Strong,Straight and Steady project, please email s.leyland@nos.org.uk.

Appendix III: Composition of Exercise Expert Steering Group and Exercise Expert Working Group

Expert Exercise Steering Group

CHAIR: Professor Dawn Skelton, Professor in Ageing and Health, Glasgow Caledonian University

Coordinator and project lead: Sarah Leyland, Osteoporosis Nurse Consultant, Royal Osteoporosis Society

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Dr Katherine Brooke-Wavell, Senior Lecturer in Human Biology, Loughborough University

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Rachel Lewis, Clinical Specialist Physiotherapist in Rheumatology, North Bristol NHS Trust

Dr Zoe Paskins, Senior Lecturer and Honorary Consultant in Rheumatology at the Primary Care Versus Arthritis Centre, Keele University

Professor Jon Tobias, Professor in Rheumatology, University of Bristol; Honorary Consultant North Bristol NHS Trust

Professor Kate Ward, Professor of Global Musculoskeletal Health, MRC Lifecourse Epidemiology Centre, University of Southampton

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Exercise Expert Working Group

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Kirsty Carne, Specialist Osteoporosis Nurse, ROS

Will Carr, Head of Service Delivery, ROS

Dr Alex Ireland, Lecturer In Physiology at the School of Healthcare Science, Manchester Metropolitan University

Vicky Johnston, Specialist Physiotherapist at the Cumbria Partnership NHS Trust

Andrea Julius, Bone Health Specialist Physiotherapist at St George's Hospital, London

Nicola Lauchlan, Clinical Specialist Physiotherapist in Osteoporosis and Falls in the Community Falls Prevention Programme, Glasgow

Sarah Legg, Senior Physiotherapist, Rheumatology at the Royal National Hospital For Rheumatic Diseases, Bath

Dr Katie Robinson, Research Physiotherapist at the School of Medicine, University of Nottingham

Yvonne Sadler, Public/patient representative

Ruth Sawtell, Public/patient representative

Christina Scorringe, Clinical Specialist Rheumatology Physiotherapist and Clinical Rheumatology Lead at Northwick Park Hospital, London

George Studd, Strength and Conditioning Coach at the Department of Sports Development & Recreation, Sports Training Village, University Of Bath

Ruth Ten Hove, Head of Research and Development at the Chartered Society Of Physiotherapy

Fizz Thompson, Clinical Director, NOS

Catherine Van't Riet, Physiotherapist and Clinical Team Lead at the Integrated Falls and Bone Health Service, St George's University Hospital, London

Appendix IV: stakeholder organisations

British Association of Sport and Exercise Sciences

British Geriatrics Society

Bone Research Society

Chartered Institute for the Management of Sport and Physical Activity

Chartered Society of Physiotherapy

Orthopaedic Trauma Society

Register of Exercise Professionals

Society for Endocrinology

PD:Approval

The Physiological Society

Appendix V: Summary of research evidence informing recommendations

Strong: Physical activity and exercise to promote bone strength and prevent fractures

Research Evidence

Observational studies suggest that day-to-day participation in physical activity reduces the risk of fracture. Age-adjusted risk of hip fractures is up to 40% lower in the most active compared with the least active adults [1]. This may be mediated through lower risk of falls and/or higher bone strength. The strongest evidence is for a reduction in the risk of hip fracture. For example, an evidence synthesis of 13 prospective cohort studies of men and women aged >35 followed up for 4-35 years identified a 38-45% reduced risk of hip fracture with higher levels of physical activity participation [2]. Similar results are seen in papers published since [3–6]. There is less evidence for the association between day-to-day physical activity and the risk of non-hip fractures, with contradictory results varying by age, functional status, physical activity, population studied and fracture type. It is hard to make conclusions on the type or intensity of the day-to-day activity that is associated with a reduction in fractures. Walking is one of the most prevalent forms of exercise and many studies suggest that those who walk for exercise have lower risk of hip fracture [3,6–8]; although this finding may reflect the increased fracture risk of the inactive reference group. A recent review suggests walking has to be part of a multicomponent intervention to potentially reduce risk of fractures [9] . An important caveat to these observational findings is that they may be confounded by factors such as health or socioeconomic status.

Randomised controlled trials allow more robust evidence regarding effectiveness of specific exercise interventions. Unfortunately, there are no adequately powered bone health randomised controlled trials with fracture as an endpoint [10] The first adequately powered falls prevention screening study, with more than 9000 people, did not show a reduction in fractures but the exercise programme employed was unlikely to influence BMD, only balance [11]. To allow comparison of specific exercise characteristics that may reduce fracture risk it is thus necessary to examine research on risk factors for fracture, such as bone mineral density or fall incidence.

A large number of randomised, controlled trials have examined the influence of different exercise interventions on bone mineral density (BMD), with most evidence in women and white populations. These have been summarized in systematic reviews and meta-analyses [10,12–33], and in previous international guidance [34–36]. It is important to highlight that BMD is just one determinant of bone strength. Exercise may also influence bone strength through BMD independent mechanisms, such as through changing the distribution of bone (bone geometry or microarchitecture) and the bone material properties [37]. There are fewer studies available with these outcome measures available at sites susceptible to fracture although a recent review concluded that novel or very intense activities can stimulate adaptations to loaded bones such as increased cortical thickness or periosteal diameter [38].

Type and intensity of exercise

As bone responds to forces applied through muscular contraction or impact forces [39], exercise can be categorized according to whether it generates impact (ground reaction) forces through weightbearing exercise, or applied load in resistance (joint reaction) exercise.

Resistance exercise

Resistance or joint reaction exercise involves work against an external load, which may be provided by free weights, weights machine, resistance band or body weight. Resistance exercise intensity may be described as a proportion of repetition maximum (1RM): the maximum load that can be lifted for the specified number of lifts before fatigue. The Cochrane review demonstrated that high-force non weightbearing exercise (>70% and usually 80%1RM) benefitted spine and femoral neck BMD, whilst low-force non weightbearing exercise (e.g. low load, high repetition strength training 40-60% 1RM) had no significant effect [26]. Other meta-analyses of resistance training alone in postmenopausal women showed benefits that did not reach statistical significance, but combined interventions of variable intensities, as well as exercises targeting different muscle groups and hence loading different skeletal sites [13,23]. Resistance training alone benefitted BMD at hip and spine sites in men [24].

Animal studies and consequent theoretical models suggest that dynamic exercise is more effective than static or isometric exercise [40,41]. Although some modest benefits to BMD have been reported with other forms of exercise that often involve static poses or slower movements, such as Tai Chi, yoga and Pilates [42,43], evidence is limited and weak [44–46]. These exercise modes may have some benefits (and risks) to outcomes other than BMD however, as discussed later.

Weightbearing/impact exercise

Weightbearing exercise involves the skeleton bearing the body weight during dynamic movement involving impact with the ground, and resultant ground reaction forces. Examples include walking, running, dancing, jumping and many weightbearing sports. The intensity of impact exercise is often defined by the magnitude of ground reaction forces sustained (although it is important to note that this does not include the concomitant muscle generated forces acting on bone). As the magnitude of forces will vary proportionately with body weight, impact forces may be expressed in multiples of body weight (BW).

According to a Cochrane review [26], high force dynamic weightbearing exercise such as jumping, skipping, aerobic dance (activities typically generating ground reaction forces >2BW) benefitted BMD of the hip and trochanter, but not spine and femoral neck; although this grouping included also whole body vibration training, which may provide very low gravitational loading. High impact exercise also increased hip but not spine BMD in premenopausal women [12,15,22] and older men [47]. Odd impact protocols (i.e. involving multidirectional movements) increased BMD at lumbar spine and femoral neck in older adults [13]. Low force weightbearing activity such as walking and low impact aerobics (that may typically incur ground reaction forces of ~1-2BW) benefitted BMD at the spine but not hip sites [26], although no significant effects of low impact exercise were reported in a meta-analysis focussing on older adults [13] whilst walking alone produced modest benefits at the hip in some but not all meta-analyses [14,48,49]. One biomechanical analysis suggests that walking must be at brisk pace to stimulate improvements [50]. However, brisk walking may increase risk of falls in those with a high falls risk [51].

Aerobic exercise is recommended for its multiple health benefits by UK Chief Medical Officers [52], as well as international bodies [53]. Whilst aerobic exercise includes impact exercises such as running, some other types of aerobic exercise may provide substantial cardiorespiratory intensity but not provide adequate skeletal loading. Examples include swimming and cycling, which did not benefit BMD [30,54]; whilst water-based exercise was less effective than land-based exercise [20].

Moderate to high impact exercise thus seems to confer skeletal benefit, with possible benefit from low impact exercise such as walking, but not from exercise where gravitational loading is reduced, such as swimming. These findings from randomised controlled trials are supported by observational studies that provide ecological validity. Using accelerometry to objectively monitor physical activity, high, but not moderate or low acceleration activities, were associated with BMD [55–57]. As accelerations do not relate directly to ground reaction forces it is not possible to determine whether these relate to high impact (previously defined as >4BW [35]) or moderate impact (2-4BW) so there was no evidence as to whether high impact exercise was more effective than moderate impact.

Combination of resistance and weightbearing exercise

Meta-analytic findings are consistent that a combination of weightbearing and resistance exercise benefitted both spine and hip sites in premenopausal women [15], postmenopausal women [13,26,29,33] and men [24]. The recent LIFTMOR studies demonstrated substantial benefits from a programme involving high intensity progressive resistance training and impact exercise in men and women with osteoporosis, with net benefits at the spine ~4% and proximal femur ~2-3% [58,59].

Sedentary behaviour

Observations from population studies suggest that lower physical activity in later life increases the risk of hip fracture [1] and that less sitting is associated with higher BMD [60]. This suggests that avoiding sedentary behaviour and maintaining standing and weightbearing activities may have a protective role in maintaining BMD [61]. A recent systematic review of sedentary behaviour and bone health in older adults shows differing associations (mostly negative) of sedentary behaviour with BMD in men and women at different BMD sites and calls for more robust studies in this area [62]. In the context of an exercise intervention, gentle walking may not generate sufficient forces to improve BMD but maintaining such activity may be important for preventing inactivity related losses. For example, a study of men and women aged 49 - 83 identified that regular walking or cycling, reduced fracture risk by up to 23% relative to hardly ever walking or cycling [5]. A recent qualitative study suggests that people with osteoporosis are knowledgeable about the detrimental effects of sedentary behaviour and easily identify facilitators to breaking up long periods of sitting, including the use of technology [63].

Exercise frequency, duration or volume

Animal studies and consequent theoretical models suggest that relatively low volumes of loading that generates high strain rates in bone can stimulate gains in bone strength; that there is desensitisation after a limited number of loading cycles, and that insertion of rest pauses can increase effectiveness [40,64]. This is consistent with observational studies in humans showing that intermittent bursts (1-2 minutes) of moderate impact exercise may be more beneficial to maintain or improve BMD

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than longer periods of low impact exercise [65]. With regard to frequency, physical activity and exercise on a day-to-day basis are associated with improved bone strength and a lower risk of hip fracture [1,66,67].

With regard to frequency of resistance exercise or combined exercise modes, the majority of studies that showed BMD improvements prescribed exercise on two or three days per week [26]. Post hoc analysis of one long-term controlled trial demonstrated that at least two sessions per week were necessary [68]. A recent randomised controlled trial of a combination of high intensity, progressive resistance training with impact exercise demonstrated that just two, 30-minute sessions per week were sufficient to increase BMD in women and men with osteoporosis [58,59].

Meta-analysis of randomised controlled trials has demonstrated that brief, high impact interventions (e.g. jumping) can increase hip BMD [12,15,22], and one study found that such exercise was most effective when performed daily, with significantly greater BMD response relative to exercise performed on just two days per week [69]. Finally, the most recent review of physical activity and osteoporosis prevention in people aged 65+ recommends multiple exercise types, including resistance exercise, for 60+ minutes, 2-3 times a week for 7+ months [25].

Site specificity

Loading stimulates very localised bone adaptation, with gains evident at only the loaded skeletal sites. Even within a single region of interest such as the femoral neck, a small overall benefit was associated with much larger localised increases in cortical and trabecular bone [70]. As such, it is important that exercise is targeted to apply loading to the skeletal sites susceptible to osteoporotic fracture, such as spine, proximal femur, and forearm, or multi-directional to load multiple sites.

At the spine, greatest benefits were observed from a combination of resistance and weightbearing activity [13,15,24–26,29]. Benefits were also observed from resistance training alone, although variability in response may arise from variation in the type or intensity of exercises incorporated [13,15,24–26,29]. Improving the strength of back muscles may also reduce the risk of vertebral fracture [71]. Impact exercise alone did not significantly benefit the spine [12,15,22].

At the proximal femur, benefits were observed from impact exercise alone [12,15,22] or in combination with resistance exercise [13,15,24,26,29]. Again, some benefits were also observed from resistance training alone, although variability in response may arise from variation in the type or intensity of exercises incorporated [13,15,24,26,29].

At the forearm, a recent meta-analysis suggests that both high and low intensity resistance training can benefit BMD although effects of impact exercise was unclear [72]. In addition, observational studies suggest that sports such as tennis that involve substantial loading of the forearm are associated with higher forearm BMD [72,73] and strength [74].

Other considerations

Some groups need specific advice. Those with eating disorders will need advice from a multidisciplinary eating disorders team [75,76] as excessive physical activity and exercise can contribute to energy deficiency and delay recovery. Similarly, elite athletes with high training volumes may benefit from sports medicine advice as they are at increased risk of overuse injuries [77,78].

Frail or sarcopenic individuals are at a higher risk of fracture and less likely to undertake physical activity [79]. Low gait speed or muscle strength may reduce the ability to undertake higher intensity activity, although gains are still possible [80–82], even in osteosarcopenic individuals [83]. The evidence that frail older people can increase bone strength through exercise is weaker but two studies of 12 and 18 months duration have shown modest effects on spine and hip BMD [83]. As bone is lost rapidly during inactivity, preventing this inactivity-related loss and using exercise to maintain muscle function and promote independence should be a priority.

STEADY- exercise and physical activity to prevent falls

The contribution of falls to fractures

95% of non-vertebral fractures, and about 20% of vertebral fractures, occur following a fall [106]. Falls and injurious falls are a significant problem in older age, with a third of people over the age of 65 falling every year [106,107]. There is a difference in the prevalence of fractures at different sites as people age. Younger people who fall may put a hand out to try to break the fall; thus wrist fractures are more common in younger people. In older people, perhaps as result of slower reactions, hip fractures are more prevalent. Hip fractures are associated with increased mortality: 6.1% of hip fracture patients die within 30 days [108], rising to over 20% in the year following fracture[6]. Of those who survive, 30% have permanent disability, 40% are unable to walk independently and 80% are unable to carry out activities of daily living (ADLs) one year after the fracture [2].

Falls: causes and risk factors

Risk factors for falls include: having had a fall in the last year; poor strength; poor balance; poor posture; bad eyesight; poor foot health; continence and health issues such as Parkinson’s disease; having had a stroke; and dementia [109]. In an ageing person, fear of falling and comorbidities can lead to a vicious spiral of inactivity. This in turn leads to a reduction in the ability to maintain an independent lifestyle and the potential for increased risk of injury [107].
Gait problems and use of walking aids, along with difficulties in everyday tasks and fear of falling almost double the risk of a fall [110]. Furthermore, people with vertebral fractures are more likely to have kyphosis or forward-flexed posture, which is associated with impaired balance [111] - 64% of people with kyphosis had had a fall in the previous year [112].

Falls risk, including problems with gait, muscle strength and balance, is modifiable with exercise [12]. Weight-bearing activities will help muscle strength and balance to some extent, although this can become more difficult in older age.

Fall prevention

There should be a health professional assessment for multiple risk factors for falls, and advice on appropriate interventions, including a specialist falls prevention exercise programme (with balance training) where available [107]. A multi-factorial approach should include medication review, bone health risk factors, and general health assessment (e.g. eyesight, continence, foot health). Environmental factors may need to be considered to address other risk factors, such as better lighting and marking edges of stairs if eyesight is failing [113].

Research evidence

Observational evidence demonstrates that those who meet physical activity guidelines for health (150 min/week of moderate to vigorous physical activity) are less likely to fall or injure themselves [21,114]. Exercise also reduces fear of falling to some extent - at least immediately after the intervention [115]. A large number of randomised controlled trials of exercise interventions on fall incidence have been conducted, as summarised in recent meta-analyses [12].

Type and intensity of exercise

The majority of studies have used balance training, often combined with strength training, sometimes incorporating also walking to meet physical activity guidelines for other health benefits [12]. Balance training is defined as the transfer of bodyweight from one part of the body to another or challenges specific aspects of the balance systems (e.g. vestibular systems) and balance retraining is defined as the re-education of basic functional movement patterns to a wide variety of dynamic activities that target more sophisticated aspects of balance [116].

Overall, exercise interventions reduced the rate of falls by 23% in older people living in the community [12]. The most effective interventions incorporated highly challenging balance training for at least 3 hours per week which reduced rate of falls by 39% [55]. The level of challenge can be increased by reducing the base of support (e.g. standing with legs closer together, then on one leg), moving the centre of gravity (e.g. reaching, transferring weight) and reducing the support from arms [55]. Most research studies included supervised sessions with an instructor to participant ratio of <10 in the supervised sessions [55]. The Otago exercise programme and the FaME (PSI) programme are evidence-based and cost effective [113].

Tai Chi reduced risk of falls in people with mild deficits of strength and balance [12]. However, if it has to be significantly modified for those with poor balance to participate (e.g. seated versions or versions without weight transfer), it loses its ability to improve lower limb strength, balance and falls risk [117].

Not all exercise modalities reduce falls [12]. Walking alone does not reduce falls risk or improve strength or balance [118]. Brisk walking may even increase risk of falls and fractures in those with a falls history [119]. For the more severely frail or those with a history of injurious falls, gradual progression from strength and balance activities to brisk walking or activities that work on stamina or endurance, may avoid an increase in falls risk [103]. Interventions that do not challenge balance sufficiently (e.g. seated programmes) have shown little or no effect on falls rates in people who are already falling, despite improvements in known risk factors, such as strength. There is currently not enough evidence to recommend dancing as a falls prevention activity for individuals with a high falls risk [12,120], although it may have the potential to reduce future falls risk in a general population.

Frequency & amount of intervention

For someone with a history of falls, 3 hours a week of strength and balance training for at least 4 months (>50 hours total) is needed to effectively reduce falls [55]. The training must be ongoing, as the fall risk reduction quickly diminishes if exercise stops. However, interventions that have a component that works on stamina as well as strength and balance, with education, have been shown to significantly increase habitual physical activity outside of sessions even a year after the intervention finishes and this is protective on maintaining falls risk reduction [121,122].

Interventions that do not provide a sufficient dose have shown little or no effect on falls rates in people who are already falling [12].

Evidence specifically concerning people with osteoporosis

Strength and balance exercise reduced pain and improved balance and co-ordination, without any adverse events in people with osteoporosis [123]. Women with osteoporosis who had completed balance training, found that they perceived improved empowerment and self-efficacy after participation in balance training. They resumed activities they had stopped and became more active and independent in daily life using safety precautions and fall-prevention strategies [124].

A substantial proportion of people with osteoporosis are also at risk of falling, so integrating a falls screening programme into routine osteoporosis care is justified [125].

Straight: modifying physical activity and exercise to reduce risk of vertebral fracture, improve posture and manage symptoms after vertebral fracture.

There are over 40,000 vertebral fractures in women each year in the UK, costing £134 million in 2010, and it is projected that this will increase to nearly 50,000 by 2025 [127]. Vertebral fractures contribute to kyphosis and cause substantial pain and disability, substantially reducing quality of life. Conversely, kyphosis can increase risk of falls and vertebral fractures [128]. Kyphosis may contribute to back pain and increase the torque applied to the anterior of the vertebral body hence increasing risk of further vertebral fractures. Furthermore, pain or fear of future fractures can limit activity [129,130], which may contribute to further bone loss as well as other adverse health outcomes.

Physical activity and exercise could benefit vertebral fracture risk by improving bone strength but also by reducing kyphosis [131,132]. Improving back muscle strength may indirectly help reduce falls risk by reducing kyphosis, although the research evidence is limited [91,111]. Vertebral fractures can cause pain, loss of mobility and reduced quality of life and may also be related to reduced respiratory function and incontinence [3,4]. Physical activity may benefit many of these outcomes in people with existing vertebral fracture.

However, people with osteoporosis are so concerned that exercise or daily activities such as bending and lifting could apply excessive vertebral loading and precipitate fracture, that they may severely curtail their activities. It is thus important to consider potential adverse effects also; both to avoid activities that may increase risk and adapt activities as necessary, but also to reassure people with osteoporosis so they can continue activities of lower risk [130].

Research evidence

Activity modification for prevention of vertebral fracture

Most vertebral fractures may occur as part of everyday living. However, the evidence in relation to *particular* day-to-day movements, or the effectiveness of activity modification to prevent fracture, is very limited. Previous guidance has thus been based largely on expert consensus [15,20,26,27]. Recommendations have been that people with vertebral fractures or osteoporosis avoid rapid, repetitive, weighted, end-of-range-of-motion movements, rotation or flexion of the spine during physical activity and exercise. This included lifting weights with a flexed spine, sit-ups and end of range yoga and Pilates postures, rapid or loaded twisting without adequate control in sports such as golf [15,20,26,27]

Kyphosis

There is some evidence that exercise can improve hyperkyphotic posture, with 8 of 11 studies reporting some improvement [31], although the studies were small and some of limited quality. The interventions that benefitted kyphosis included spinal extension exercises and yoga, delivered by a physiotherapist or trained instructor [31]. Recent trials of spinal extension exercise also benefitted kyphosis [131,133], whilst high intensity resistance and impact training in people with low BMD showed improvements to kyphosis as well as BMD [60,85].

Exercise in management of vertebral fracture

Recent Cochrane reviews evaluated exercise interventions in people with existing vertebral fracture [11,53]. In some, but not all individual trials, there were benefits to physical function, pain, and/or quality of life. Subsequent studies have also shown improvements in pain and physical function [134]. The recent UK-based PROVE trial showed that physiotherapist prescribed home exercise had some short term benefits on quality of life and back muscle endurance and kyphosis relative to provision of information only, but these were not sustained in the longer term [132].

Few studies in the Cochrane review had reported adverse events. An updated systematic review found few further adverse events reported in three subsequent trials [56]. In one trial that reported incident fracture, none were sustained during the exercise intervention and there were an equal number of vertebral fractures in the exercise and control group. Whilst the number of non-vertebral fractures was greater in the control group, this difference was not statistically significant [134]. The PROVE trial of over 600 participants reported no directly associated adverse events with exercise [132]. It should be highlighted that these interventions were usually led by trained physiotherapists although some included home exercises after checking of correct form.

A consistent finding in the reported trials has been of poor adherence to the exercise interventions and it is recommended that any exercise programme needs to include strategies to enhance long-term adherence [132,135]

Appendix VI: Implementation in a UK context

Implementation

This consensus statement provides clear consistent advice, which has previously been missing, for people living with osteoporosis and health professionals working with them about the evidence for, and safety of, exercise. To ensure effective implementation of the strong, steady, and straight exercise approaches, there are factors that act as both facilitators and barriers to implementation that need consideration. These include appropriate and timely identification and management of people living with osteoporosis by primary and secondary care providers; provision of exercise interventions that conform to evidence-based requirements and the complexity of providing multiple exercise programmes for different long-term conditions in the context of limited resources; and uptake and adherence to exercise interventions (short-term and long-term). Osteoporosis exercise programmes, like other falls and other exercise programmes for older people and those with long term conditions, need to be more than a prescribed set of exercises. They need to consider education and physical literacy, support and goal setting, motivation strategies, behaviour change techniques and take into consideration their needs and preferences [87,88].

As barriers, these factors lead to disparity and variation of services across the UK, and, therefore, inequity of access. For example, osteoporosis management in primary care is not always a key priority. Whilst osteoporosis indicators are included in the quality and outcomes framework this is to record information about management of patients who have sustained a fragility fracture; primary prevention is not included. Whilst primary care clinicians may offer lifestyle advice including advice on exercise and increasing physical activity, as part of their approach to treating osteoporosis [89], they may not refer onto bone strengthening exercise programmes; although it is likely referrals will be made for the sub group of people with osteoporosis who are at risk of falls. Nevertheless, the link between strong, steady, and straight exercise approaches in this consensus statement provides an opportunity for improvement through integrated falls prevention and bone health exercise pathways. For example, as osteoporosis is a musculoskeletal condition there is opportunity for first contact practitioners (FCPS) funded through the primary care direct enhanced service additional role reimbursement scheme (ARRS) [90] to lead on screening, assessment and management of osteoporosis, osteopenia and falls in primary care as part of an integrated care pathway. Systemic issues related to how exercise for osteoporosis is delivered could be addressed through FCP influence and leadership, with physiotherapists in such roles leading in the development and delivery of exercise programmes. This guidance will enable FCPs to replicate effective programmes in clinical practice.

The most recent UK Fracture Liaison Service database (FLS-DB) annual report [91] showed only five percent of non-hip fracture patients over 75 from participating services had started strength and balance training within 16 weeks of their fracture in 2018; and this was no improvement on the proportion referred in 2017 (also 5%). This is an improvement area for the FLS-DB beyond 2021 and with an increasing number of FLS-DB services being established/commissioned this should further improve screening and identification of those likely to benefit from exercise for osteoporosis; and support more education and lifestyle change, over and above what is currently being realised, particularly regarding bone strengthening exercise.

The impact of COVID on exercise services and the influx of prevention and rehabilitation needs post-COVID has the potential to jeopardise the offer of exercise for conditions such as osteoporosis. Competition for resources may result in exercise interventions being deprioritised. Effective partnership working, perhaps incorporating direct messaging to people with osteoporosis, is particularly pertinent if we are to respond to the impact of COVID restrictions including interrupted or delayed access to osteoporosis services and/or reduced physical activity levels

For effective implementation of the strong, steady, and straight exercise approaches there is a need to build in infrastructure for measuring and monitoring for quality assurance and improvement - to ensure ongoing fidelity to original effective components (right populations targeted by right professionals, dose, frequency, intensity, challenge, resistance etc.); to demonstrate impact, and to justify investment in osteoporosis programmes. One possible solution to the barriers described might be a system wide infrastructure to support exercise referral, similar to the National Exercise Referral Scheme (NERS) in Wales [92]. This evidence-based scheme not only incorporates physical activity and behaviour change interventions, but it standardises exercise referral opportunities across all Welsh Local Authorities and Local Health Boards. The aim of the scheme is to reduce the inequalities in health by providing access to tailored and supervised physical activity whilst supporting partnership working across health and community services and between healthcare and exercise professionals. For such a scheme to work for osteoporosis, access to consistent education to train health and exercise professionals on benefits of exercise for osteoporosis and to demystify the risk of harm, especially in vertebral fracture, would be paramount.

This consensus statement has updated and consolidated previous guidance as well as placing it in a UK context. Key recommendations are that people with osteoporosis should undertake resistance and impact exercise to maximise bone strength; should take part in activities to improve strength and balance to reduce falls and undertake spinal extension exercise to improve posture, and potentially reduce pain levels caused by vertebral fractures, risk of falls and vertebral fracture. Although we recommend avoiding postures involving a high degree of spinal flexion (especially weighted) during exercise or daily life, and that people with vertebral fracture or multiple low trauma fractures should only exercise up to an impact equivalent to brisk walking, there is limited evidence of harms from exercise. People with vertebral fractures may benefit from exercise to reduce pain, improve mobility and quality of life, ideally with advice from a physiotherapist. Most importantly, inactivity should be avoided and physical activity encouraged and reassurance provided to counter the fear of moving that could detrimentally affect bone strength and health/quality of life more broadly.

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