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Muscle and bone strengthening and balance activities for general health benefits in adults and older adults

Summary of a rapid evidence review for the UK Chief Medical Officers' update of the physical activity guidelines

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The rapid evidence review was funded by a grant from the Centre for Ageing Better.



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Published July 2018

PHE publications

gateway number: 2017207

PHE supports the UN

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Abbreviations

CMO	Chief Medical Officer
FITT	Frequency, Intensity, Time and Type of physical activity
GoPA	Global Observatory for Physical Activity
IAG	Implementation Advisory Group
KPIs	Key performance indicators
MBSBA	Muscle and bone strengthening and balance activities
MeSH	Medical Subject Headings
OP	Osteoporosis
PRT	Progressive resistance training

Executive summary

This report summarises a rapid evidence review of muscle and bone strengthening and balance activities (MBSBA) for general health benefits in adults and older adults by a working group advised by a UK Chief Medical Officers' (CMOs) Expert Committee for muscle strength, bone health and balance. It makes suggestions for actions to implement the findings for the public, practitioners and policy makers.

The UK CMOs' physical activity guidelines for adults and older adults comprise four elements: cardiovascular activity; strengthening activities; activities to improve balance and coordination; and reducing prolonged sedentary (sitting) time.

There is an imbalance in awareness, achievement and monitoring of these three components of the guidance, with MBSBA being considered "the forgotten guidelines". In order to maximise the health potential of increasing physical activity and avoid discrepancy of attention and resources, there is a need for a common consensus on the role of MBSBA within physical activity in terms of the contribution of these activities to health, independent of aerobic activity.

Findings of the evidence reviews

In reviewing the evidence for health benefits across life stages and for specific health outcomes, evidence was identified that demonstrates the importance of strength and balance activities to improve bone and muscle health and physical capacity at any age, and - in middle and older age - to maintain and improve function and reduce all-cause and cardiovascular mortality.

The reviews highlight increasing evidence on strengthening and balance activities for general health benefits, and suggest that all adults and older adults should "undertake a programme of exercise at least twice per week that includes high intensity resistance training*, some impact exercise (running, jumping, skipping etc.) and balance training. The specific exercises included and the volume of exercise per session should be tailored to individual fitness and physical function."

*High intensity resistance training involves the major muscle groups, with each exercise performed with the maximum weight that can be lifted 8-12 times without losing good technique or to the point of involuntary fatigue.

The evidence highlighted the variable impacts of different types of sport, physical activity or exercise.

Although most evidence identified was for adults aged 60 years or older, consideration was made of how MBSA varies across the life course and particular ages where activities are most important. At ages 18 to 24 years MBSBA maximise bone and muscle gains; at ages 40 to 50 years MBSBA maintain strength and slow the natural decline; and in over-65 years MBSBA preserve strength and maintain independence. Strength and balance exercise may also improve future health outcomes at specific transition points in life where there is likely to be an increase in sedentary behaviour or loss of muscle function, including pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation.

Specific consideration was given to different types of physical activities and exercise needed for particular 'at-risk' populations. This review identified studies suggesting that for:

- the prevention of falls in people with a falls history and/or frailer older adults - structured exercise programmes that incorporate progressive resistance training (PRT) with increasing balance challenges over time are safe and effective if performed regularly, with supervision and support, over at least six months.
- those with a high risk of fracture, (poor balance, frailty, vertebral fractures) - supervised structured exercise programmes are most appropriate. For those in transition to frailty who have poor strength and balance, activities that are known to help maintain strength and balance (such as Tai Chi) are effective in reducing falls risk.
- those in transition to frailty with poor strength and balance – Activities to maintain strength and balance (such as Tai Chi) are effective in reducing falls risk.
- very frail older adults – Supervised structured exercise that has PRT, balance training and some aerobic endurance activities, supervised and progressed by a trained person, are advocated.

Barriers and enablers for individuals undertaking MBSBA are similar to those that apply to physical activity more generally. The evidence highlighted specific barriers to resistance training for older people, which were a mix of personal, social and environmental. Based on these findings specific principles were produced for developing and testing messaging both for individuals and for practitioners who support them.

An evidence review on options for population surveillance highlighted the potential for strength and balance to be simply and reliably measured via direct (eg handgrip dynamometer) or indirect (eg walking speed, chair rise, standing balance and timed get up and go) assessments to supplement existing subjective surveillance.

Suggested actions for stakeholder groups

The public:

- individuals need to ensure they undertake strengthening and balance activities suitable for them at least twice per week
- for those at risk of falls or fracture due to poor fitness or physical function, supervised structured exercise is recommended
- specific consideration of and undertaking strengthening and balance activities is important at key transition points in life: pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation

Practitioners:

- service providers and health professionals should recognise and develop approaches that address barriers to MBSBA, with materials and resources developed to help practitioners feel confident they can tailor MBSBA activities within existing services
- organisations for health professionals (eg royal colleges) and exercise professionals should present the benefits and risks of MBSBA to their members and users via curriculum, training, resources and materials that support their professional practice and confidence

Policy makers:

- health and social care commissioners should recognise and value the health, social and economic benefits and outcomes of MBSBA and that for some specific populations, promotion of MBSBA would be a better option than promoting only aerobic activities
- commissioners are encouraged to support the implementation of the **Falls and Fractures Consensus Statement**, but also recognise the vital role MBSBA plays across all populations and its positive contribution to social care and mental health services
- the evidence supports future physical activity guidelines giving equal weighting to MBSBA. Associated public messages need to be clear, action-orientated (ie how much and what types of activities contribute) and tailored to current levels of physical activity and capability; they should also be tested and developed for different segments of the population
- a strategy should be developed for capacity building and service delivery to support professional bodies and their members, that includes referral routes, key performance indicators, cost benefit tools, and specific muscle strength and balance related training
- the potential of direct and indirect objective measurements (functional assessment and accelerometry) to supplement existing surveillance systems should be explored, at both national and local levels (eg the Active Lives Survey)

Introduction

The UK Chief Medical Officers' (CMOs) guidelines for adult and older adult physical activity outline evidence-based, age-specific recommendations for physical activity for good health.¹ Each of the guidelines covers four elements: cardiovascular activity; strengthening activities; activities to improve balance and coordination; and reducing prolonged sedentary (sitting) time.

Preserving musculoskeletal function via physical activity and exercise is a prerequisite for maintaining mobility and independent living during later life. The UK physical activity guidelines recommend that adults aged 19 to 64 years should “undertake physical activity to improve muscle strength on at least two days a week” and adults aged 65 years and older who are at risk of falls should “incorporate physical activity to improve balance and co-ordination on at least two days a week”.¹

The first National Sport Strategy in over a decade, ‘Sporting Future’, brought a welcome and renewed focus on increasing physical activity as a means to achieving cross-society health, social and economic outcomes.² Achieving the UK CMOs’ guidance is a high level indicator, but the associated key performance indicator focuses solely on the cardiovascular element. At the same time, work on healthy ageing and falls prevention is increasingly focusing on muscle and bone strengthening and balance activities (MBSBA).

There is a real challenge faced in physical activity promotion with unequal emphasis on the aerobic rather than the strength components of the UK physical activity guidelines for adults. This imbalance was neatly captured by Strain et al.’s “The forgotten guidelines” paper.³ Muscle and bone health and the ability to balance are underpinning components of physical activity. Each contributes independently to overall health and functional ability and can offer lifelong benefits across the life course. Each contributes via mechanisms promoted by regular participation in physical activity and exercise. Muscle and bone mass ordinarily peaks before the age of 30, and muscle and bone strengthening activities are required to slow the decline in bone and muscle density to maintain capacity and function.¹

Muscle strengthening activities are considered at national level through a subjective, self-reported metric within the Health Survey for England.⁴ However, it is not included within the Active People Survey or the new Active Lives Survey⁵ and therefore is not reported at local level. Balance activities are not explicitly measured.

In order to maximise the health potential of increasing physical activity and avoid discrepancy of attention and resources, there is a need for a common consensus on the

role of MBSBA within physical activity in terms of the contribution of these activities to health, independent of aerobic activity.

The UK CMOs have commissioned a review of the current UK guidelines on physical activity across the life course which is examining evidence for all the components of the 2011 UK CMO physical activity guidelines. This report summarises a rapid evidence review of MBSBA for general health benefits in adults and older adults and makes suggestions for implementation of the main findings for the public, practitioners and policy makers.

Methods

The scope of the rapid evidence review was limited to adults and older adults (ie 18 to 64 years and 65 years and over). Relevant literature was identified to answer six research questions. The six questions were:

1. What are the health benefits of muscle and bone strengthening and balance activities across life stages and specific health outcomes?
2. What types of physical activities are effective in developing muscle and bone strength and balance?
3. How do muscle and bone strengthening and balance activities (MBSBA) vary across the life course, and are there particular ages where MBSBA are most important?
4. Which strength and balance activities are safe and efficacious for individuals with specific challenges (osteoporosis, vertebral fractures, frailty, dementia)?
5. What are the main barriers and enablers for individuals to undertaking MBSBA activities?
6. What are the measurement options for population level surveillance of MBSBA?

As each review question examined different types of study design (observational, experimental or qualitative) it was not possible to apply one set of quality criteria across all evidence reviews. Authors identified the best available evidence from systematic reviews and/or meta analysis or primary studies. Where possible authors noted the quality of the evidence in the reviews by assessing the presence or absence of heterogeneity in the size and direction of the effect or association and the strength of the association. Full details of the methods and results of these questions, as well as the various studies and sources used, are published in a special issue of the [Journal of Frailty, Sarcopenia and Falls, Volume 3, Issue 2](#).

For each question, a set of recommendations and evidence statements were produced in relation to the strength and balance physical activity guidelines and issues for implementation in practice and policy. The UK CMOs' Expert Panel for MBSBA scrutinised the evidence reviews with support from PHE and the Centre for Ageing Better.

For questions 1 to 5, narrative literature reviews were undertaken to identify relevant review level literature for adults and older adults. The searches focused on evidence published since 2010 using PubMed (ie the end date for the literature used to develop the existing UK CMOs guidance). A set of broad MeSH (Medical Subject Headings) terms were employed to capture the most current studies published with standard search limitations. For example, "resistance training", "muscle", "bone", "balance" AND "physical activity" AND "adults". Defined terms for muscle function, balance and bone health were used (see Table 1).

Table 1: Definition of terms for muscle function, balance and bone health⁷

Term	Definition
Muscle function	Muscle function is necessary to permit movement and maintain posture. Sensory receptors in the muscles monitor the tension and length of the muscles and provide the nervous system with crucial information about the position of the body parts.
Bone health	Bone health includes bone quality that refers to the capacity of bones to withstand a wide range of loading without breaking. Bone health also includes bone mineral content, structure, geometry and strength.
Balance	A performance-related component of physical fitness that involves the maintenance of the body balance while stationary or moving.

Searches for international evidence reviews of physical activity used to construct national physical activity guidelines and recommendations (published since 2010) were undertaken using Google, and by targeting the websites of public health bodies (ie National Centre for Health and Clinical Excellence, Centre for Disease Control). International experts were also contacted to identify further examples of relevant reviews. The most relevant and up to date high quality reviews were identified from these sources and summations made of the effectiveness of the evidence relevant to questions 1 to 4.

Synthesis of the evidence was based on two types of studies; observational and experimental. Observational studies provided evidence to support the associations of specific frequency, intensity, time and type (FITT) of physical activity in relation to health outcomes and reductions in mortality and morbidity. Experimental studies identified the evidence of causal effects (effectiveness and efficacy) for FITT of physical activity upon physiological outcomes and markers of chronic disease.⁶

For question 4, systematic reviews looking at the efficacy of MBSBA and progressive resistance training (PRT), strength and balance exercise were examined to look for any advice on efficacy and safety in frailer older people and in those who have had previous fractures or who have osteoporosis or dementia. Because there is little research or reviews that specifically focus on risks of injuries or adverse events associated with strength or balance exercise or activities, a scoping review of the literature was performed. A search on NCBI PubMed, Google Scholar Position Stands and International Reviews of Physical Activity Evidence was undertaken, with Cochrane reviews identified that contained interventions based on strength and balance activities (for adverse events and risks of injury) and also on literature on strength and balance interventions (or both, multimodal) for frailer older people, those with osteoporosis and/or vertebral fractures and those with impaired cognition.¹¹

For question 5, primarily qualitative literature of reviews on professional and personal barriers and motivators for MBSBA among older people were identified.

To answer question 6, survey data held on national surveillance practices by the Global Observatory for Physical Activity (GoPA) was evaluated. National surveillance practices were reviewed to determine whether they included questions on MBSBA. In addition, the calculation and reporting of each survey was reviewed to confirm whether achievement of the strength and balance recommendations was factored into the national prevalence estimates.

The results of each evidence review (questions 1 to 5) were presented to an Implementation Advisory Group (IAG) at a facilitated workshop. The IAG members represented a broad spectrum of main stakeholder groups from commissioning, service providers, allied health professionals and patient representatives. All were asked to reflect on the evidence to provide advice on implementation challenges and the practicality of making MBSBA recommendations central to the groups they represent. Facilitated group work and open discussion considered the following questions:

1. What are the implications for communicating the MBSBA guidelines?
2. What are the implications for commissioning?
3. What are the implications for capacity building and service delivery?
4. What are some key things that need to change in order to embed these guidelines into routine physical activity promotion practices?

The output of the IAG workshop shaped the suggestions for actions for the public, practitioners and policy makers.

Supporting evidence

What are the health benefits of muscle and bone strengthening and balance activities across life stages and specific health outcomes?

Data from 20 systematic reviews were examined, including some narrative meta-analyses.⁸ There was consistent evidence that preserving muscular strength and power in middle and older age was associated with a reduced risk of mortality from all causes and cardiovascular mortality. There was some evidence to suggest that gait speed in older adults was associated with a reduced risk of incident cardiovascular disease and hospitalisation. There was only weak evidence suggesting an association between muscular strength and obesity, hypertension and metabolic syndrome. Higher levels of muscular strength and power in older adults were associated with higher levels of mental wellbeing. Low levels of muscular strength and power as well as balance in older adults were associated with an increased risk of a first fall, recurrent falls and falls that lead to injury.

Supervised exercise interventions undertaken at least twice a week that included a combination of high intensity resistance training, exercises that involved impact (eg, running, jumping), balance training or Tai Chi led to improvements in physical function and bone health and reduced the risk of falls. There was some evidence to suggest that when the concentric phase of resistance training is undertaken at high velocity (power training) effects were improved.

The effects of muscular strength or balance training alone on measures of motor and cognitive function were unclear. Only limited evidence was available to suggest there may be an association between strength or balance training on one dimension of self-reported quality of life (vitality), and there was insufficient evidence to draw conclusions about the effect of strength and balance training on activities of daily living. It was unclear whether the prescribed exercises associated with positive effects on bone health observed in supervised exercise programmes can be achieved in home-based exercise programmes as too few studies have examined this question.

What types of physical activities are effective in developing muscle and bone strength and balance?

Data from 19 systematic reviews and meta-analyses was examined, as well as a recently published national evidence review.⁹

Consistent evidence was found that strength/resistance training as a single intervention or in combination with other activities, on two/three occasions per week, were effective in building muscular strength, with higher intensities of training producing greater gains.

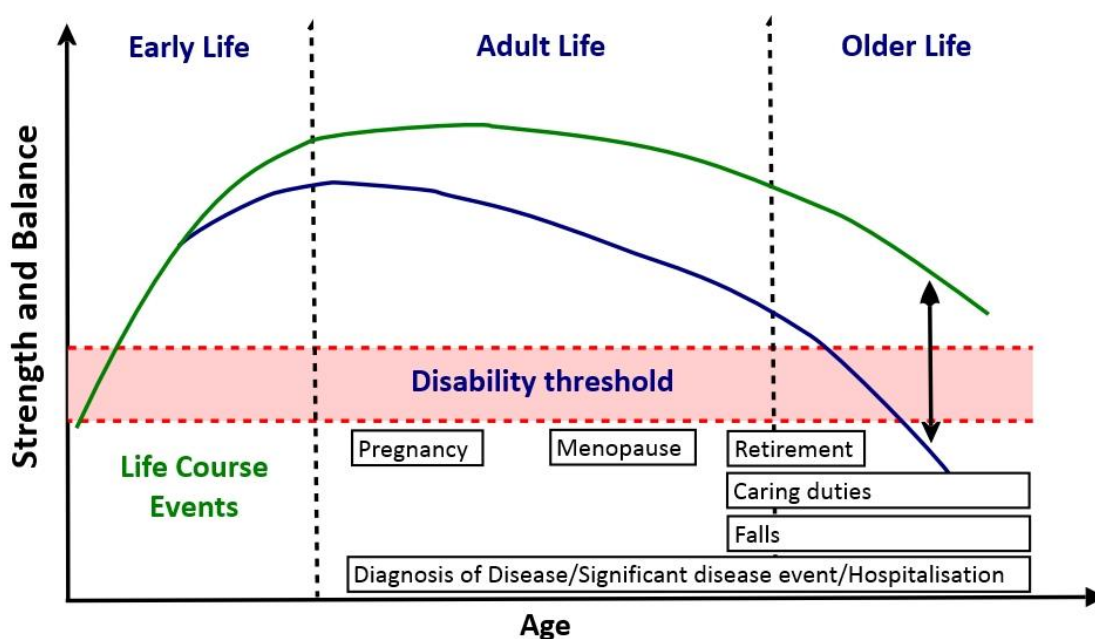
The evidence suggests that physical activities with a high challenge to balance undertaken three times per week were beneficial for balance training and falls reduction. Also evidence suggests that strength training as a single intervention or in combination with high impact loading activities undertaken at least three times per week was effective for bone health.

Insufficient evidence was identified to conclude the efficacy of general physical activities such as walking or cycling, and exercise including computerised balance programmes or vibration plates, on clinical measures of balance. Walking, despite cardiovascular and other health benefits, was found to have a low beneficial effect for either bone health or balance and falls reduction, with only small gains in muscle strength reported, increasing to moderate gains for Nordic walking.

How do muscle and bone strengthening and balance activities (MBSBA) vary across the life course, and are there particular ages where MBSBA are most important?

Evidence from observational studies suggests that muscle strength, bone strength and balance ability increase in childhood and peak in early adulthood, eventually followed by a decline (see Figure 1).¹⁰

Figure 1 Strength and balance ability over the life course and potential ages or events that may change the trajectory of decline with ageing



Key: Green Line denotes successful ageing with good health and regular strength and balance activity. Blue line denotes the decline in strength and balance if not part of activity throughout lifespan.

Source: Skelton DA, Mavroeidi A (2018) How do muscle and bone strengthening and balance activities (MBSBA) vary across the life course and are there particular ages where MBSBA are important. *Journal of Frailty, Sarcopenia and Falls* 3(2): 74-84

Opportunities for promotion of and enactment of strength and balance activities may be beneficial at the following specific times in life:

- ages 18 to 24 years to maximise bone and muscle mass gains;
- ages 40 to 50 years to maintain strength and slow the natural decline; and
- over 65 years to preserve balance and strength and maintain independence.

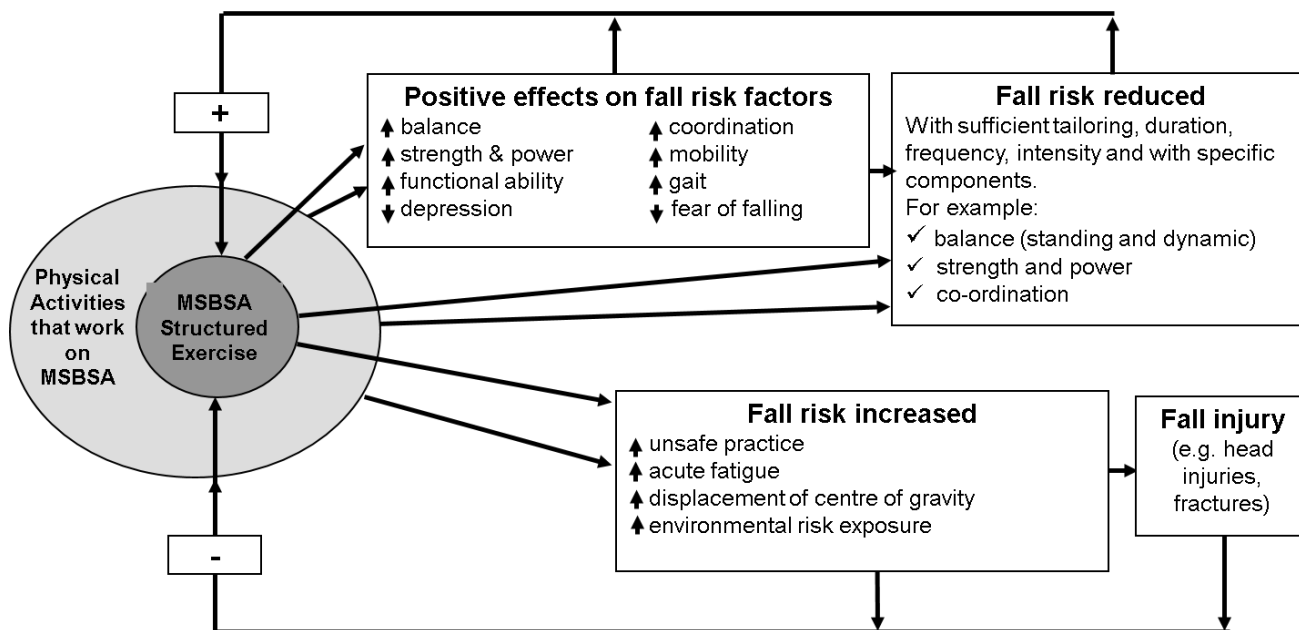
It also highlights specific transition points/events in life as being optimal times to instigate strength and balance exercises in order to improve future health outcomes: pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation.

Which strength and balance activities are safe and efficacious for individuals with specific challenges (osteoporosis, vertebral fractures, frailty, dementia)?

Systematic reviews on the efficacy of MBSBA and PRT were examined for efficacy and safety in frailer older adults and those with previous fractures or who have osteoporosis or dementia, as well as coverage of risks of injuries or adverse events in Cochrane reviews and the literature on strength and balance interventions.¹²

Figure 2 shows that although the benefits outweigh the risks, poor technique, fatigue and the effect this may have on the body's ability to respond to trips, and an environment which can increase risk of falls, amongst other potential risks, can increase the chances of a fall or injury as a result of taking part in these activities.

Figure 2: Potential risks and benefits of muscle and bone strength and balance structured exercise programmes and physical activities that can improve strength and balance



Source: Skelton DA, Mavroei A (2018) Which strength and balance activities are safe and efficacious for individuals with specific challenges (Osteoporosis, Vertebral Fractures, Frailty, Dementia)? : A Narrative Review. *Journal of Frailty, Sarcopenia and Falls* 3(2): 85-104

For prevention of falls in people with a falls history and/or frailer older adults, structured exercise programmes that incorporate progressive resistance training (PRT) with increasing balance challenges over time were safe and effective if performed regularly, with supervision and support, for at least six months. Some minor adverse effects (mainly transient musculoskeletal pain) were reported.

For those with a high risk of fracture (poor balance, frailty, vertebral fractures), supervised structured exercise programmes were most appropriate. For those in transition to frailty who have poor strength and balance, exercises that are known to help maintain strength and balance (such as Tai Chi) were effective in reducing falls risk. For the very frail older adult, the evidence suggests supervised structured exercise that has PRT, balance training and some endurance work, supervised and progressed by a trained person are efficacious.

Table 2 summarises the considerations for older adults taking part in strength and balance sport and recreational activities. A Consensus Statement is under development by the National Osteoporosis Society on exercise recommendations for people with osteoporosis, and will be finalised in late 2018. This forthcoming (more in-depth) review of the literature may alter

Table 2 recommendations.

Table 2: MBSBA and recommendations for engagement in older adults, with osteoporosis, with vertebral fractures, and frailer older people

Type of Sport, Physical Activity or Exercise	Considerations			
	Older adults (>50 yrs)	Osteoporosis (OP)*	Older people with vertebral fractures*	Frailer older people /Significant cognitive impairment
Running	Green	Orange	Orange	Red
Resistance training	Green	Green	Orange	Orange
Aerobics, circuit training	Green	Green	Orange	Red
Ball games	Green	Orange	Orange	Red
Racquet sports	Green	Orange	Orange	Red
Golf	Green	Orange	Orange	Orange
Yoga, pilates	Green	Orange	Orange	Orange
Tai Chi	Green	Green	Orange	Orange
Dance	Green	Orange	Orange	Orange
Cycling	Green	Orange	Orange	Red

* all people with diagnosed osteoporosis should understand safe lifting of weights (technique and spine sparing movement)

Key:

■ not recommended-potential fracture risk (from a fall or propulsive high resistance activity) even if have a history of the activity, based on recommendations with information on case reports or adverse events with some of these activities. Discussion with physiotherapist for spine sparing tips if practiced in activity.¹⁴

■ not recommended if inexperienced to the activity (OP or frailer older people), without advice on spine-sparing techniques, and avoidance of repetitive (even if slow), weighted or rapid end range flexion or extension of the spine (for those with osteoporosis). Emphasis should be placed on slower more controlled movements. Frailer older people (or those with high falls risk or multiple comorbid conditions affecting balance or strength) should be supervised by a physiotherapist or exercise instructor that has had specific training on adapting and tailoring exercise prescription for those with osteoporosis based on recommendations.⁹

■ no considerations if have good strength and balance (low risk of injury) or are practiced in this activity (history of participation). Focus on good technique is important.

Source: Skelton DA, Mavroei A (2018) Which strength and balance activities are safe and efficacious for individuals with specific challenges (Osteoporosis, Vertebral Fractures, Frailty, Dementia)? : A Narrative Review. Journal of Frailty, Sarcopenia and Falls 3(2): 85-104

People with various levels of cognitive impairment can benefit from supervised strength and balance exercise for about 60 minutes a day, two to three days a week, to improve physical function. Tai Chi and yoga show evidence of efficacy and safety for those with mild to moderate cognitive impairment. Although there is little evidence of any muscle strength and balance activities being inherently unsafe, for those who are frail, have vertebral fractures or have severe cognitive impairment, it is appropriate to recommend supervised progressive strength and challenging balance exercises on a one-to-one or

small group basis. Indeed for these individuals, supervised progressive strength and challenging balance exercise are both safe and will be more effective than unsupervised activities, in terms of important outcomes for function, fracture prevention and mortality.

What are the key barriers and enablers for individuals to undertaking MBSBA activities?

There were 12 papers reviewed that considered evidence on professional and personal barriers and motivators for strength and balance activities among adults (aged 40 to 74 years and older adults).¹³

Many of the reported barriers and motivators to strength and balance activities were ones that also apply to physical activity more generally, such as not having the time. More specific barriers to resistance training for older people were perceived risk of a heart attack, stroke or death, and fear of looking too muscular; with motivators being improved ability to complete daily activities, preventing deterioration and disability, and decreasing fear of falling.

The barriers identified are not straightforward, as they are a complex mix of personal, social and environmental factors. Messages need to be developed for and tested with individuals to support their engagement and participation in MBSBA activities based on the themes identified within the qualitative literature.

What are the measurement options for population level surveillance of MBSBA?

Surveys used to inform the 139 Global Observatory for Physical Activity (GoPA) country card prevalence estimates were reviewed to determine questions on muscle strengthening and balance activities.¹⁴

Of the 139 countries with GoPA country cards, 21 countries reported having no physical activity prevalence data. The remaining 118 countries had prevalence data on physical activity and cited the survey that was used to generate the estimates. The physical activity prevalence estimates for 74 countries were taken from the World Health Organization 2014 Global Status Report on Non-Communicable Diseases. For the remaining 44 countries, a range of national and international surveys were used. A very limited number of tools sought to assess muscle strengthening activities, and even fewer assessed balance and coordination activities.

Five national surveys (from the 139 participating countries) were found to include questions explicitly asking about muscle strengthening activity. These were: the Health Survey for England; the Scottish Health Survey; the Health Survey for Northern Ireland; and the Behavioural Risk Factor Surveillance Surveys conducted in Puerto Rico and Guam.

Given the presence of common measures of muscular strength, power and balance in many UK birth cohorts and studies of ageing, there may be considerable value in supplementing existing surveillance studies of physical activity with a small number of objective measures that are cheap and quick to do such as hand grip strength, walking speed, chair rise, standing balance and timed get up and go. The objectivity of these measures would avoid the misclassification associated with estimates based on self-reports of behaviours. In addition, combining prevalence data with data from epidemiological studies would allow for estimates of the health gain associated with population changes in these measures.

Limitations

A range of limitations were encountered across the reviews:

Scope of searches: reviews considered were limited to those published in the English language).

Quality of the original studies, systematic reviews and meta-analyses: many of the studies reviewed were randomised controlled trials with objective exposure and outcome measures. Less constancy in exposure measures was found in observational studies plus inadequate control of potential confounding factors. In particular, when mortality or morbidity was the outcome it was not possible to rule out the possibility of residual confounding nor the possibility of reverse causality.

Scope of evidence base: the review was tasked with addressing effects over the lifespan, but apart from a few studies the bulk of the evidence was undertaken in adults at least aged 60 years and older. Therefore although a broader range of ages were represented in the included studies, results are still mostly applicable to adults over the age of 60 years with clear benefits for the very old.

Heterogeneity in study interventions: The development of guidelines seeks to identify an 'optimum' exercise prescription, but this was not possible, due to differences across trials (eg heterogeneity in the exercise prescription, the length of programs and follow up periods). The major limitation of trials included in the reviews was the lack of intention to treat analysis.

Summary of findings

Implications for future guidelines

This review highlights increasing evidence on strengthening and balance activities for health benefits and suggests that all adults and older adults should: undertake a programme of exercise at least twice per week that includes high intensity resistance training*, some impact exercise (running, jumping, skipping etc.) and balance training. The specific exercises included and the volume of exercise per session should be tailored to individual fitness and physical function”.

*High intensity resistance training involves the major muscle groups, with each exercise performed with the maximum weight that can be lifted 8-12 times without losing good technique or to the point of involuntary fatigue. When 13-14 repetitions of a given exercise can be completed the load should be increased.¹⁵

Types of physical activities that contribute to improvements in muscle function, bone health and balance are shown in Table 3.

Table 3: Assessment of the positive impact of different types of sport, physical activity or exercise on muscle, bone and balance outcomes

Type of Sport, Physical Activity or Exercise	Improvement in Muscle Function	Improvement in Bone Health	Improvement in Balance
Running	X	xx	x
Resistance training	xxx	xxx	xx
Circuit training	xxx	xxx	xx
Ball Games	xx	xxx	xxx
Racquet Sports	xx	xxx	xxx
Yoga, Tai Chi	X	x	x
Dance	X	xx	x
Walking	X	x	0
Nordic Walking	xx	NK	xx
Cycling	X	x	x

Key: xxx = Strong effect; xx = medium; x = low; 0 = no effect; NK = not known

Source: Foster C, Armstrong M (2018) What types of physical activities are effective in developing muscle and bone strength and balance? *Journal of Frailty, Sarcopenia and Falls* 3(2):58-65.

Evidence suggests that it is important to initiate strength and balance activities to improve physical capacity at all ages and – in middle and older age – to reduce all-cause and cardiovascular mortality.

Evidence also suggests that initiating strength and balance exercise would improve future health outcomes at specific transition points in life where there may be an increase in sedentary behaviour or loss of muscle function, including pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation.

For prevention of falls in people with a falls history and/or frailer older adults, evidence indicates that structured exercise programmes that incorporate progressive resistance training (PRT) with increasing balance challenges over time are safe and effective if performed regularly, with supervision and support, over at least six months. Some minor adverse effects (mainly transient musculoskeletal pain) have been reported.

For those with a high risk of fracture (poor balance, frailty, vertebral fractures), supervised structured exercise programmes are most appropriate.

For those in transition to frailty who have poor strength and balance, activities that are known to help maintain strength and balance (such as Tai Chi) are effective in reducing falls risk.

For the very frail older adult, supervised structured exercise that has PRT, balance training and some aerobic endurance work, supervised and progressed by a trained person are advocated.

Barriers to undertaking MBSBA

The barriers identified in these review are not straightforward, as they are a complex mix of personal, social and environmental factors.

Themes within the evidence suggest the following main principles for developing and testing messages for individuals to support their engagement and participation in MBSBA activities:

- maintaining muscle strength is important as you age: to keep you strong, flexible, agile and independent
- aim to do some strength and balance activities twice a week. Build them into your life
- strength activities can help you feel younger, have improved energy, sleep better and look fitter
- balance activities can help reduce your risk of falling

- they can also make you feel better about yourself, and help you feel you have accomplished something
- exercise in groups or gyms is a great way to meet people and have fun
- you are never too old to start
- if you are an older person, and not feeling too strong, you may be at risk of a fall, which can lead to other problems (activities to build strength and balance help reduce risk of falls. Find out from a health professional if you are at risk of falling, and join a group or class to reduce your risk, meet people and have fun)

Similarly, the following main principles for developing messages to practitioners to support individuals' engagement and participation in MBSBA activities can be suggested:

- plan programmes and sessions that older people want to come to (and keep coming to)
- emphasise the benefits that older people identify for themselves
- explain and communicate the importance of strength and balance activities (especially for older people)
- be aware that many older people do not want to be categorised as such and market your programmes appropriately
- adapt the level and intensity of the programme to the needs of the participants
- for falls prevention, explain carefully the risk of falls and how strength and balance activity can reduce falls (but without necessarily labelling it as a 'falls programme')

The evidence also highlights the case for exercise providers to consider providing targeted (age-appropriate) services for older people; ensure staff are appropriately trained and have knowledge of normal changes in performance of resistance training by older people; and appropriate prescription and progression of exercise based on capability assessment and health status. Services and programmes need to be marketed by focusing on the positive attributes of strength training that have been identified as motivators by older people. This could include such factors as increasing muscle strength to improve health and physical functioning, preventing functional decline or deterioration and disability, providing a sense of belonging, feeling more alert, having better concentration and stimulating the mind.

Measurement options for population level surveillance

Muscle strength and balance components of the physical activity recommendations are rarely measured in national surveillance systems and are not considered when calculating national prevalence estimates.

The evidence highlights that muscle strength and balance are easy to assess through direct (eg handgrip dynamometer) or indirect (eg walking speed, chair rising and the timed get up and go) assessments, and there is merit in exploring supplementing existing surveillance systems with these objective measurements.

Suggestions for action

Following consideration of the evidence by the Implementation Advisory Group, the following practical actions for implementation of the findings are proposed for the following groups:

The public:

- individuals need to ensure they undertake strengthening and balance activities suitable for them at least twice per week
- for those at risk of falls or fracture due to poor fitness or physical function, supervised structured exercise is recommended
- specific consideration of and undertaking strengthening and balance activities is important at key transition points in life: pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation

Practitioners:

- service providers and health professionals should recognise and develop approaches that address barriers to MBSBA, with materials and resources developed to help practitioners feel confident they can tailor MBSBA activities within existing services
- organisations for health professionals (eg royal colleges) and exercise professionals should present the benefits and risks of MBSBA to their members and users via curriculum, training, resources and materials that support their professional practice and confidence

Policy makers:

- health and social care commissioners should recognise and value the health, social and economic benefits and outcomes of MBSBA and that for some specific populations, promotion of MBSBA would be a better option than promoting only aerobic activities
- commissioners are encouraged to support the implementation of the **Falls and Fractures Consensus Statement**, but also recognise the vital role MBSBA plays across all populations and its positive contribution to social care and mental health services
- the evidence supports future physical activity guidelines giving equal weighting to MBSBA. Associated public messages need to be clear, action-orientated (ie how much and what types of activities contribute) and tailored to current levels of physical activity and capability; they should also be tested and developed for different segments of the population

- a strategy should be developed for capacity building and service delivery to support professional bodies and their members that includes referral routes, key performance indicators, cost benefit tools, and specific muscle strength and balance related training
- the potential of direct and indirect objective measurements (functional assessment and accelerometry) to supplement existing surveillance systems should be explored, at both national and local levels (eg the Active Lives Survey)

Conclusions

From the reviews of evidence by a working group advised by a UK Chief Medical Officers' (CMOs) Expert Committee for muscle strength, bone health and balance on the health impacts of MBSBA on health outcomes, there is a consistent body of evidence to support the inclusion of MBSBA activities across the whole life course to improve bone health and physical capacity at any age, and - in middle and older age – to reduce all-cause and cardiovascular mortality. Furthermore this evidence suggests that MBSBA would improve future health outcomes at specific transition points in life where there may be an increase in sedentary behaviour or loss of muscle function, including pregnancy, menopause, onset of/on diagnosis of disease, retirement, on becoming a carer or following hospitalisation.

There is a need to tailor the correct types of MBSBA to each individual's experience, fitness and functional ability. This will demand resources in the dissemination of guidance to practitioners and the public to gain awareness and traction. Implementation across practice, service provision, commissioning, policy and surveillance will require resources, commitment and leadership from national and local stakeholders and will require a dedicated new strategy and delivery plan. Otherwise MBSBA guidelines will remain forgotten.

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Appendix

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