Supplementary file 1. Rapid evidence review

SUMMARY OF EVIDENCE REVIEW PROCESS

A rapid review of the literature was done to establish what is known about the risks of physical activity (PA) and exercise in people with long-term conditions (LTCs). This was presented to the steering group during the consultation phase. Once the symptom-based approach and clinical priorities for the consensus statement were established by the steering group, this review was used in the creation of the symptom-specific evidence statements.

AIMS OF EVIDENCE REVIEW

Provide an overview of existing guidelines and/or recommendations that address the risks of PA for people with long-term conditions, including:

1. What has previously been done to understand the associated risks?
2. What conclusions or consensus were reached?
3. How were conclusions or consensus reached?

Where possible, and using the findings from Aim 1, summarise the nature and incidence of recognised risks (morbidity and mortality) from physical activity by long-term conditions.

METHODS

The approach adopted for this review was a Rapid Evidence Review. This reflected both the nature of the question, and the time and resources available.

In terms of selecting relevant literature the following AGREE II criteria were used:

- Target population: adults (18-64 years) and older adults (65 years+), patients with one or more chronic condition undertaking physical activity;
- Study designs: position statements', 'consensus statements', 'guidelines' and 'recommendations';
- Comparisons: not applicable;
- Outcomes: quantified or qualified risks of physical activity;
- Language: Available in English;
- Context: not applicable.

The online search was conducted in September-October 2019 using four major databases including PubMed, Google Scholar, Scopus and Web of Science. The chronic conditions listed on the Moving Medicine website were used as search terms, and included: 'cancer', 'COPD' ('chronic obstructive pulmonary disease'), 'dementia', 'depression', 'falls' and 'frailty', 'inflammatory rheumatic disease', 'ischaemic heart disease', 'musculoskeletal pain', 'type 2 diabetes mellitus'. Additional search terms including 'mental health', 'rheumatoid arthritis', 'heart disease' and 'cardiovascular disease' were used to ensure that publications were not excluded due to different nomenclature used in different countries.

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Furthermore, the search also included conditions/symptoms that are typically associated with the chronic conditions listed on the Moving Medicine website; including 'Parkinson's disease', 'Alzheimer's disease', 'osteoarthritis', 'high blood pressure', 'hypertension', 'obesity', 'lower back pain'. The search terms 'adults' and 'older adults' were used to assess risk of physical activity under the heading of 'primary prevention'. Papers that reported on children and adolescents exclusively were excluded, as well as publications that exclusively covered conditions including fibromyalgia, HIV/AIDs and palliative care.

The search was targeted to 'position statements', 'consensus statements', 'guidelines' and 'recommendations' regarding PA and exercise prescription within each condition mentioned above. Search statements used (though not limited to) included: 'position statement on physical activity in (*insert condition*)', 'risks associated with being physically active', 'risks with physical activity prescription', 'risks with exercise prescription', 'practical considerations exercise prescription in (*insert condition*)' and 'consensus on the risks associated with physical activity'.

For publications where an academic body or organisation (such as the American Diabetes Association, ADA; or American College of Sports Medicine, ACSM) had more than one guideline or position statement, the most recent version was used.

In addition to the search for peer-reviewed publications and towards the end of the review process, an additional search for foundations, charities, and organisations that provide PA guidance for people with chronic conditions in the United Kingdom (UK) was conducted. Search statements for this component of the review process included, but were not limited to, statements such as '(*insert condition*) and physical activity UK', exercise and (*insert condition*) UK' and 'exercise prescription in (*insert condition*) UK'. It is important to note that the organisations and foundations identified in this component of the search process do not always give recommendations or discuss risk based on sound scientific evidence. For this reason, the results of this search are kept separate from the results generated from the primary search described above.

SUMMARY OF RESULTS

The findings of this rapid review suggest that there are condition-specific risks associated with the prescription of PA and/or exercise. However, these risks are outweighed by the benefits of PA for all conditions covered by this review. There is variability between conditions in terms of what has been done, and the specificity of recommendations or guidance.

The evidence is supportive of good prescription practice that involves a patient-centred approach, whereby PA and exercise prescription is tailored to the needs of the patient. A patient-centred approach can be demonstrated in several ways, such as:

- Knowing if and when supervised PA/exercise is required;
- Understanding the condition of the patient according to their symptoms, and not according to their diagnosis or disease exclusively;
- Considering the level of function of a patient according to their physical capabilities within their disease, and not according to their disease exclusively.

RESULTS IN RESPONSE TO AIMS

a) What has previously been done to understand the associated risks of physical activity in people with long-term conditions?

Seventy-nine relevant reports (reviews, consensus statements, position statements or guidelines) from around the globe were identified as relevant to this question. An overview of the work reviewed is shown in Table 1. It is worth noting that several references consider more than one condition. An overview of the search for foundations and/or organisations that provide PA guidance for people with chronic conditions is also shown in Table 1.

The majority of reports screened for this review primarily emphasise and report on the benefits of PA and/or exercise, and only some addressed the associated risks. When risks are addressed, (i) they are treated as secondary to the benefits; and (ii) they are not always specific to the condition in question.[1]

b) What conclusions or consensus were reached?

When risk is reported, it is discussed in one of three main ways:

1. The risks of PA are weighed against benefits, and the benefits of PA are usually stated to be greater than any potential risks;
2. Generic risks of PA or exercise-induced injury, that would also apply to a healthy population, are reported more often than condition specific risks;[2]
3. The risks of PA are addressed in a way that is not necessarily backed by empirical scientific evidence, but rather using a 'common sense' approach.

Specific risks and considerations as outlined in the various documents are summarised by condition in Table 1.

c) How were conclusions or consensus reached?

For the publications and documents included in this review, conclusions and consensus has been reached in the following ways:

1. For review papers (where recommendations are made following the either systematic or non-systematic review of evidence) the statements are "evidence based" though not always condition specific;
2. For consensus statements, position statements or guidelines, the consensus has been reached following panel discussions. The panels are either made up of medical professionals/clinicians, researchers/academics or a combination. No statements based on Delphi methods have been identified in this review;
3. For some publications including guidelines and position statements, the conclusion has been drawn based on expert opinions. These experts are professionals/clinicians, researchers/academics or a combination

Table 1: Overview of literature reviewed and findings, shown by disease.

Condition and references	Summary of findings	Additional PA considerations	Relevant UK Organisations
Cancer [3–13]	There is no evidence to suggest that PA may worsen the condition of an individual with cancer or undergoing cancer treatment. The risks associated with cancer largely depend on the type and site of cancer (e.g., physical activity following a surgery close to the arms may need to be adjusted). Overall, individuals with cancer are encouraged to exercise as tolerated, and to pay attention to signs/symptoms and the state of their immune system. Specific signs/symptoms or considerations to be aware of include lymphoedema, pain, and chemotherapy-induced peripheral neuropathy. Exercising while supervised may be required.	-Presence of lymphoedema -History of surgery -Presence of pain -Presence of chemotherapy-induced peripheral neuropathy -Be aware of the area affected by the cancer – particularly for bone cancer (for risk of fracture) -Exercise as tolerated (presence of signs/symptoms and state of immune system is particularly important) -Supervision may be required	-Cancer Research UK Exercise Guidelines -The BASES Expert Statement on Exercise and Cancer Survivorship -MacMillan Cancer Support Guidance -NHS – Guys and Thomas -Pancreatic Cancer UK Information and Support -Prostate Cancer UK Guidance -Lymphoma Action UK Guidance -Breast Cancer Now Information
COPD [3,4,6,7,14–21]	An important consideration for patients with COPD is the severity of the condition. As the severity of the condition increases, the level of risk increases. For high-risk, symptomatic COPD patients, PA should be replaced with pulmonary rehabilitation, in which case supervision may be required. There is evidence that PA should be avoided due to increased risk in COPD patients during an infective episode or if the patient is in the immediate recovery phase of an exacerbation. If a COPD patient exercises as tolerated and in a manner that is tailored to their condition, and in an environment that is not polluted, there is no evidence to suggest that PA may worsen the condition of an individual with COPD.	-Timing of exacerbations -Risk of infections -Co-morbidities -Exercise as tolerated (presence of symptoms is particularly important) -Supervision may be required -Prescription of exercise should be tailored	-British Lung Foundation Support -NHS Inform Living with COPD
Dementia [3,4,6,7,22–24]	There is no evidence to suggest that PA may worsen the condition of an individual with dementia. However, exercise and/or PA should be made safer for individuals with dementia, as these individuals tend to have issues related to forgetfulness, balance, gait, and proprioception. Furthermore, these issues can worsen as the disease progresses and therefore the stage of the disease is an important consideration. Prescription of PA should be tailored to the needs of the individual and should be supervised when needed.	-Forgetfulness during activities -Safety related to balance, gait and proprioception -Stage of the disease is important -Tailored prescription as per the needs of an older adults (where applicable -Supervision may be required	-Alzeimer's Society United Against Dementia Guidance -Department of Health: 'Nothing Ventured, Nothing Gained': Risk guidance for people with dementia

Depression [6,7,25–29]	There is evidence that a low risk of 'physical activity dependence' exists in the general population, and this risk may be somewhat higher for people with depression. However, this is extremely rare overall. There is also evidence that PA should not be prescribed to an underweight depressed individual as there is a potential link with disordered eating. Provided that an individual with depression exercises or is physically active in an environment or setting that is not related to the source or trigger of the depression (e.g., avoiding group activities for someone with social phobia) and is not underweight due to an eating disorder, there is no evidence to suggest that PA may worsen the depressive condition of an individual with depression.	-Source of depression (linked to self-esteem and also eating disorders) -Link timing of PA and exercise to depressive symptoms -Exercise dependence (and therefore a negative motivation)	-Mind Tips -Mental Health Foundation Guidance
Falls and Frailty [3,4,16,30–37]	There is evidence that anyone who exercises or engages in PA incurs some risk for an adverse event (including a fall with fracture), but this is at any age. Exercise and PA prescription should be tailored according to the individual's physical condition, level of function and presence of other disease(s) or disability. Supervision may be required for some individuals, and risk may be attenuated by making exercise and/or PA safe through changes to the home environment, selecting appropriate exercise equipment and footwear.	-Exercise (in general) increases acute risk of falls (and potentially fractures) -Presence of other diseases (Multi-morbidity) -Older adulthood is a special consideration and level of function is important -Supervision may be required -Safety (in terms of the home, exercise equipment and footwear) should be considered.	-Age UK guidance for older adults and guidance for falls prevention -National Osteoporosis Society / Royal Osteoporosis Society and British Geriatrics Society Consensus statement
Inflammatory Rheumatic Disease [3,4,6,16,38–42]	There is risk of harming a joint if improper technique is used when stretching, exercising and being physically active, especially if there is existing inflammation. In this regard, supervision may be required. Exercise and/or PA should be tailored according to the individual's physical condition (including the weight status of the patient), level of disability, the degree of pain and inflammation present in the joints needing exercise, as well as the personal preference of the patient. Another potential consideration is that of drug therapy (and the interactions with PA). It is necessary for post-exercise discomfort and pain to inform following exercise sessions. While some muscle soreness (or stiffness) is expected for an individual who is untrained, prescription should change if symptoms of the disease worsen.	-Supervision may be required -Presence of joint pain -Footwear is potentially important -Tailor exercise as per the needs and preference of patient, as well as disease activity (inflammation) -Be aware of medications and interactions with PA -Discomfort and pain post-exercise is important to inform following exercise sessions -Overweight or obesity may limit choice of PA/exercise	-National Rheumatoid Arthritis Society Guidance -ARMA: Arthritis and Musculoskeletal Alliance Guidance -Versus Arthritis, Arthritis Research UK Policy Position

Ischaemic Heart Disease [3,4,6,7,16,43–49]	Supervision during exercise and/or PA is recommended for patients with heart disease, especially higher-risk patients, who may also require monitoring throughout their PA and/or exercise. It is important to be aware of medications and the interactions with PA (e.g., beta-blockers attenuate heart rate response). Hypertensive patients should avoid the Valsalva manoeuvre during resistance training, and exercise should be avoided in the case of systolic BP >180 mmHg and/or diastolic BP >105 mmHg. There is evidence that anyone who exercises or engages in PA incurs some risk for an adverse event. However, the evidence suggests that it is unlikely that a cardiac event that occurs during or soon after exercise is because of the exercise. Rather, it is likely that the individual had an underlying condition that was exacerbated by exercise. Exceeding the recommended dose of exercise or PA may increase the risk for recurrent cardiovascular events. Provided that a heart disease patient exercises within their limitations and are risk-stratified correctly, there is no evidence to suggest that PA may worsen the condition of an individual with heart disease.	-Supervision is recommended -Acute risk of adverse event -Higher-risk patients need supervision and monitoring -Be aware of medications and interactions with PA -Presence of other diseases and conditions (particularly hypertension and obesity) -Hypertensive patients should avoid the Valsalva manoeuvre during resistance training. Exercise to be avoided in the case of systolic BP >180 mmHg or diastolic BP >105 mmHg	-Heart UK (Cholesterol Society) Guidance -Cardiomyopathy UK Guidance -British Heart Foundation Information
Musculo-skeletal pain [3,4,6,7,16,50–53]	For lower back pain specifically, it is important to determine whether the pain is acute or chronic. Thus, obtaining an accurate diagnosis is important before prescribing exercise or PA. Exercise should not be prescribed for individuals with acute lower back pain. Abdominal bracing may cause further harm in some back conditions and is therefore not recommended. Walking downhill may aggravate symptoms in individuals with spinal stenosis. For individuals with other forms of musculoskeletal pain, the evidence suggests that appropriate PA (that is tailored to the individual) is unlikely to cause harm.	-Differences between pain that is acute vs. chronic. Exercise not always indicated for acute back pain. Diagnosis is important before prescribing exercise or PA -Tailored prescription of exercise -Abdominal bracing may cause further harm in some back conditions -Walking downhill may aggravate symptoms in individuals with spinal stenosis. -Risk of increasing damage -Risk of increasing pain	-ARMA: Arthritis and Musculoskeletal Alliance Guidance -Versus Arthritis, Arthritis Research UK Policy Position
Type 2 Diabetes [3,4,6,16,44,54–63]	For type 2 diabetic patients, supervision is recommended depending on symptom severity. Tailored PA and/or exercise prescription is necessary. The evidence suggests that diabetic individuals with neuropathy (autonomic and peripheral) and retinopathy may be at an increased risk of injury during PA and/or	-Supervision is recommended -Tailored prescription necessary -Presence of peripheral neuropathy (footwear is important in this regard) -Presence of autonomic neuropathy	-Diabetes UK Guidance -My Diabetes, My Way Scotland NHS Guidance

	exercise. For patients presenting with retinopathy, the Valsalva manoeuvre during resistance training, and high-impact vigorous exercise, should be avoided. Footwear is important for diabetic patients. Additionally, diabetic individuals with poorly controlled glycaemia may need to modify their PA and exercise, as well as note their carbohydrate intake. Patients with diabetes are often overweight or obese and so it is important to note the presence of other diseases, and to also be aware of prescribed medications. Provided that a patient with diabetes is examined effectively (to determine the optimal dose when weighing risks versus benefits, e.g., running may be better for biological outcomes but may increase risk of injury), there is no evidence to suggest that PA may worsen the diabetic condition of an individual.	-Presence of retinopathy (patients should avoid the Valsalva manoeuvre during resistance training, and high-impact vigorous exercise) -Risk of hypo- and hyper-glycaemia -Be aware of medications and interactions with PA (also note carbohydrate intake) -Presence of other diseases and conditions (particularly obesity)	
Primary Prevention [1–3,64–77]	For adults and older adults that are 'apparently healthy', there is an acute risk of adverse event during vigorous exercise. There is also a general risk of (musculoskeletal) injury during vigorous activity for all healthy people, and this is reduced by proper warming-up, stretching, strength training, and balance training. It is important to note that the risk of injury is relative to the size of the increase in PA and that older age, as well as previous injury, increases risk of further injury. There is evidence that there is an attenuation (and perhaps a reversal) of benefits in the case of too much PA is a risk. However, "too much" is defined as being at the extreme of the PA continuum (e.g., people who participate in ultra-endurance events and who reserve little time for adequate rest).	-Acute risk of adverse event during vigorous exercise -General risk of injury (musculoskeletal injury) for all healthy people exists. Reduced by warming-up, stretching, strength training, and balance training. The risk of injury is related to the size of the increase in activity. -Previous injury increases risk of further injury -In older adults, risk of injury is increased (by comparison to adults due to limited functional ability, previous inactivity, previous illness) -Too much PA is a risk: there is an attenuation (and perhaps a reversal) of benefits at the extreme of the PA continuum (people who participate in ultra-endurance events and/or reserve little time for adequate rest)	-
Multi morbidity [6,78]		-Tailored prescription necessary -Be aware of any competing diseases.	-

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