NHS London

PHYSICAL ACTIVITY AND LONG TERM CONDITIONS

A GUIDE FOR GPs

Intelligent Health

go london

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INTRODUCTION

In 2012 while the world was watching the London Olympic and Paralympic Games, 41% of those living in the tower blocks of Newham, a stone's throw from the stadium, are classified inactive. The recent *Lancet* editorial on physical activity says that inactivity contributes to 9% of premature deaths worldwide which is an equivalent burden to health as smoking[1].

The evidence over the past 10 years has now made inactivity perhaps the greatest threat to physical and mental health and a key contributing factor to the rise in diabetes and many other long term conditions. Increasing evidence is showing that inactivity is as an important risk factor for many chronic health conditions as smoking, hypertension and an even greater risk factor than obesity.

The King's Fund said "Caring for people with long-term conditions – for example, heart disease, asthma and diabetes – is a major element of the NHS's work. There are 15.4 million people in England with at least one long-term condition, and it is thought many more are not yet diagnosed. Three out of every five people aged over 60 in England suffer from a long-term condition. The UK economy stands to lose £16 billion over the next 10 years through premature deaths due to heart disease, stroke and diabetes."

As a legacy of the London 2012 Games, NHS London has initiated a programme called My Best Move to get those people with Long Term Conditions more active. The first stage of My Best Move delivered training to over 60 practices covering almost every London borough. The second stage will be to distribute this leaflet and have trained GPs delivering training to their neighbouring practices with the aim that all practices in London will eventually have a basic understanding of how and when to promote physical activity.

This booklet is to help primary care staff to use physical activity in the care of their patients. But it is a start and should be seen as work in progress. We have only tackled eight long term conditions and we want to know which further ones to add. We want this book to be used in the consultation to help GPs feel confident in recommending physical activity.

Please do not hesitate to contact us and tell us what is good and what is bad about this booklet and accompanying training and how we might change things in the next version.

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A

BACKGROUND AND INTRODUCTION TO PHYSICAL ACTIVITY AND BRIEF INTERVENTIONS

01

HOW IMPORTANT IS PHYSICAL ACTIVITY?

- More premature deaths will be prevented by addressing very low levels of cardiorespiratory fitness in a local population than for any other risk factor.
- Physical activity is as effective as many other therapies in treating long term conditions.

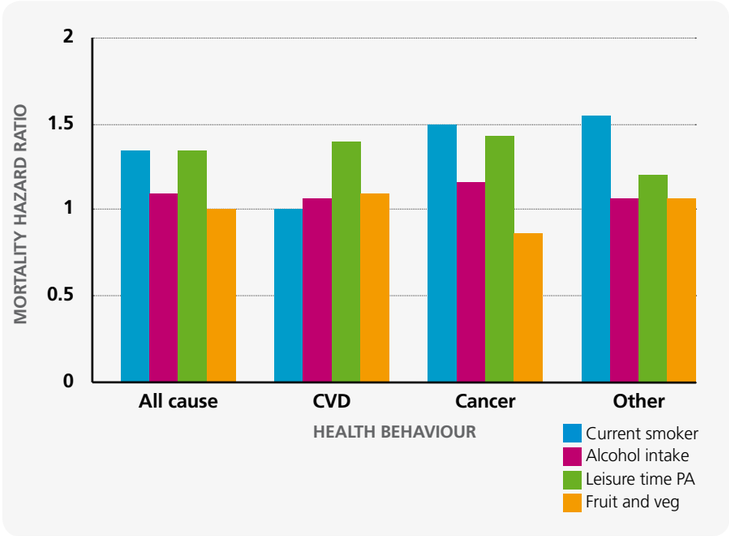
Physical activity is a lifestyle factor in disease and premature mortality, along with diet, smoking and alcohol. Lifestyle factors account for 80% of long term conditions in the UK.

The importance of each lifestyle factor can be calculated in terms of the magnitude of its effect on an **individual** or the effect it has on a **population** if everyone with that unhealthy lifestyle changed to a healthy lifestyle.

A UK study following up 4886 adults for 20 years looked at **the individual** risk of each of four main lifestyle factors[2]. The researchers calculated how much the risk factors contributed to all-cause mortality, CVD and cancer mortality based on each health behaviour. For physical activity the population was divided into those completing >2 hours and <2 hours of leisure time activity per week. In Figure 1 the results show that smoking and inactivity have equal all-cause mortality hazard ratios but that for cardiovascular disease physical inactivity is the most important risk factor.

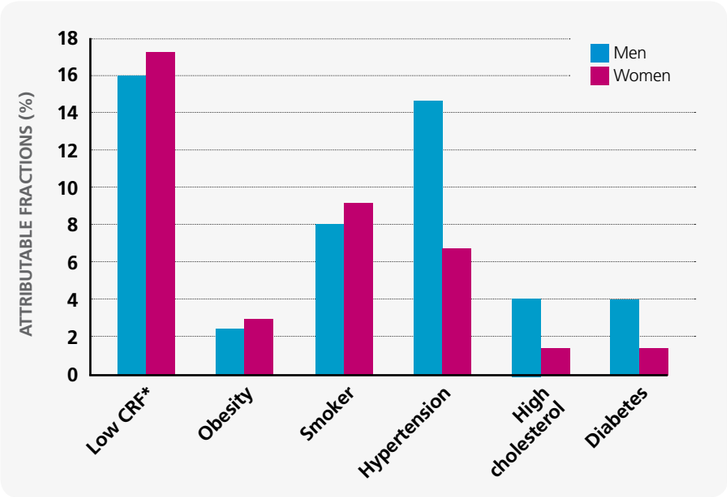
To estimate **population** risk, we need to know the effect it has on each individual but also how many people are affected. This allows the calculation of the *attributable* fraction. In Figure 2 the attributable fraction is an estimate of the number of deaths in a population that would have been avoided if a specific risk factor had been absent. That is, if all smokers were non-smokers or all those with low Cardio Respiratory Fitness (CRF) improved their fitness♦. The data is based on follow-up of a large population of women and men in the Aerobics Centre Longitudinal Study (ACLS)[3]. This study reported, as shown graphically below, that low cardiorespiratory fitness (CRF) accounts for about 16% of all deaths in both women and men in this population, and this is significantly more, with the exception of hypertension in men, than the other risk factors.

Figure 1: Individual health behaviours in relation to mortality risk in 4,886 men and women 18 yrs or older at baseline in 1984-1985 (Kvaavik, 2010)



♦ CRF = Cardiorespiratory Fitness. This is an objective measurement involving performing a maximal aerobic test on a treadmill

Figure 2: Attributable fractions (%) for all-cause deaths in 40,842 (3,333 deaths) men and 12,943 (491 deaths) women in the Aerobics Centre Longitudinal Study (Blair, 2009)



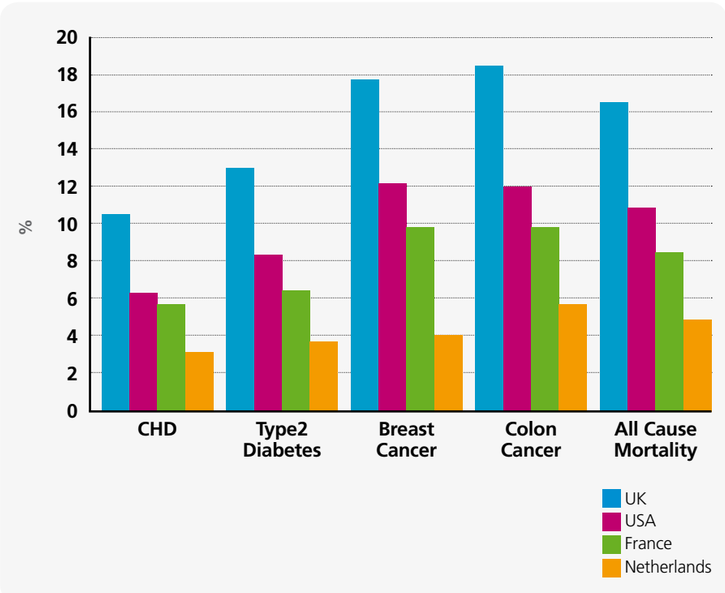
Increasing levels of physical activity and in particular cardio-respiratory fitness should be a priority for primary care and public health to both prevent and treat the main long term conditions affecting the UK.

In the recent *Lancet* series on physical activity the population attributable fraction of mortality due to inactivity was calculated for every country for four diseases and all-cause mortality. The data shows that physical inactivity contributes more to mortality than almost every other large country in the world even when compared to the US which is generally considered to have worse obesity problems than the UK (see figure 3).

Cost of physical activity

The Cabinet Office calculated that physical inactivity costs England over £8.2 billion[4]. This includes direct health costs and indirect costs such as absenteeism, premature death and social care.

Figure 3: Population Attributable Fraction of mortality due to Inactivity (%). Lee I-M *et al*. Effects of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet* 2012 Published online July 18.



Direct cost savings to the NHS in London through physical activity

There are 4,134 FTE GPs in London. If each GP managed to convert two inactive patients per month to become active, then over one year a total of about 10,000 patients will have been lifted out of inactivity. This is just over 5% from the current total of 1.8 million inactive patients doing less than 30 minutes a week.

Allender et al[5] calculated that the direct cost to the NHS of physical inactivity in England was £1.06 billion per year. This is acknowledged by the authors as being an underestimate since arthritis, prevention of falls and the social care required to look after the elderly who have become dependent due to inactivity are not included. It also does not include the large burden on mental health. Table 1 shows the costs of inactivity for each disease area. This is further adapted for London which has 6.1 million adults or 14.7% of England's **adult** population of 41.4 million adults.

Table 1: Using data from the Allender et al study to calculate the approximate NHS savings from just five disease areas by lifting 5% of the inactive population into activity. The savings of £7.8 million exclude potential savings from musculoskeletal, respiratory disease, mental health and general NHS care of the frail elderly

Disease	% of total NHS costs	Direct costs 2002 (£ million)	Cost due to physical inactivity	Cost due to physical inactivity✦ (£m London)	Potential saving through My Best Move♦ (£m London)
Ischaemic Heart Disease	3.3	2287	526	77	3.8
Cerebrovascular Disease	4.1	2892	347	51	2.5
Breast Cancer	0.3	240	26	4	0.3
Colorectal Cancer	0.5	383	61	9	0.45
Diabetes	1	675	101	15	0.75
Total	**9.2**	**6477**	**1061**	**156**	**7.8**

Getting more patients active is based on sound economics[6] for GPs. Patients who are inactive have:

- 38% more days in hospital
- 5.5% more family physician visits
- 13% more specialist services
- 12% more nurse visits

✦ 7% of all adults living in England (41.4 million) are in London (6.1 million)

♦ 1.83 million London adults (30%) are inactive (< 30mins activity per week). An assumption is made lifting 100,000 people out of inactivity will reduce the burden of direct NHS costs by about 5%. (100,000/1830000=0.055)

02

A FEW BASICS ABOUT PHYSICAL ACTIVITY

How do you measure intensity of activity?

There are two ways in which the intensity of activity can be defined: the **MET** and **Kcal/min.**

The **MET** is short for Metabolic Equivalent. One MET is the energy you use when you are dozing on the couch. It is the energy required to keep your heart, liver, brain, muscles functioning and is equivalent to your basal metabolic rate (BMR). Two METS therefore uses up twice that amount of energy. The average person walking will be using 3-4 METS and running uses between 5-12 METS. See the table below for some examples of activities and their metabolic equivalent.

The **kCal/min** is the number of calories you burn up for each activity. However unlike the MET which is a ratio, kCal/min depends on the person's weight as a heavy person requires more energy to move. A 60kg person walking at 4 mph uses up 5.4kCal/min but a 75kg person uses up 6.5kCal/min.

What is Cardiorespiratory Fitness (CRF)?

Everyone is capable of an individual maximum amount of aerobic physical activity. This is defined as cardio-respiratory fitness and is strongly related to the risk of all-cause mortality. It can be measured in METS or in terms of oxygen consumption as VO_{2maX}. Cardio-respiratory fitness declines with age by about 10% per decade. Most people reach their cardio-respiratory fitness peak in their mid-twenties. The rate of decline is influenced by genetics, illness and the amount of physical activity that people do. Someone with a cardio respiratory fitness of 10 METS would only be able to carry out an activity of 10 METS for a few minutes or so before becoming exhausted. However an activity of 5 METS would account for 50% of their oxygen uptake so they would feel very comfortable in the 'moderate activity' range.

Table 2: Minimum cardiorespiratory fitness by age and gender (METS), below which there is a significant increase in cardiovascular risk[8]. 8 METs is approximately equivalent to walking continuously at 4mph for 1 mile. 6 METS is equivalent to walking at 3mph

Age (years)	40	50	60
Men	9	8	7
Women	7	6	6

How do you measure cardiorespiratory fitness?

The gold standard method to assess cardiorespiratory fitness is to measure oxygen uptake while performing exercise. This is usually done using a treadmill or cycle ergometer. The person is asked to exercise to their maximal output. This is not only uncomfortable but also limited to those who have been screened and deemed not at risk and the test needs to be carried out in a controlled environment. There are many sub-maximal measures which will give a reasonably accurate indication of CRF. A ready calculation of CRF can be made using an algorithm derived from measurements of CRF in large populations[7] under laboratory conditions.

A 1 MET increase in CRF reduces all-cause and CHD/CVD mortality by 13% and 15% respectively. This is comparable to a:

- 7 cm reduction in waist circumference[9]
- 5 mmHg fall in systolic blood pressure[10]
- 1-mmol/L fall in triglyceride level[11]
- 1-mmol/L fall in fasting plasma glucose[12]
- 0.2 mmol/L increase in HDL[13].

Table 3: a comparison of different MET values and how they relate to stages of health

Maximum Fitness	Comment
<3 METS	Severely limited functional capacity. Candidate for a heart transplant.
3-5 METS	Poor prognosis in cardiac patients. Highly deconditioned individual.
8 METS	This is the minimum for good health in middle aged population and younger
10 METS	Good prognosis for cardiac patients on medical therapy. Approximate value for regularly active middle aged patients.
13 METS	Excellent prognosis regardless of disease status
18 METS	Athletes
20 METS	World class athletes

How are activities categorised into moderate or vigorous?

Activities are graded according to the amount of energy you expend doing them. Activities that expend 3-6 METS are classed as moderate activity. Above 6 METS they are classed as vigorous activity.

However this is not accurate for everyone. For example if an activity like walking at 4mph has an intensity of 4.5 METS then someone who has a fitness level of 9 METS will be working at 50% of their maximum capacity which is defined as "moderate". However someone much older or less fit with a fitness level of 6 METS will be working at 75% of their capacity which is defined for them as "vigorous". The same activity will therefore feel "moderate" for the fit person but "vigorous" for the unfit person.

So it is more accurate to define an activity according to the patient's experience when doing it. Box 1 shows the definitions that are used by the Department of Health.

Patients can use their heart rate to determine the intensity of the activity. Moderate and vigorous activity is 64-76% and 77-93% of the maximal heart rate respectively. The maximum heart rate is calculated at 220 minus age although there is a large standard error[14]. Patients on beta-blockers or with arrhythmias cannot calculate their percentage heart rate.

Box 1: Definition of Moderate and Vigorous Activity (Department of Health 2011)

Physical activity needs to be of at least moderate intensity to benefit health. A person who is doing moderate intensity activity will usually experience an increase in breathing rate and an increase in heart rate, will feel warmer and may sweat on hot or humid days.

Someone undertaking vigorous intensity physical activity will usually be breathing very hard, be short of breath, have a rapid heartbeat and be unable to carry on a conversation.

To demonstrate minimal fitness for their health a middle aged person should be able to walk at 3mph for 1 mile comfortably. For those over 70yrs this walking speed will outpace the walking speed of the Grim Reaper✦.

In the UK 5.3 million people aged between 25 and 64yrs have such low fitness that they would find walking at 3mph a vigorous activity♠.

✦ Stanaway FF *et al* How fast does the Grim Reaper walk? Receiver operating characteristics curve analysis in healthy men aged 70 and over: *BMJ*. 2011; 343: d7679

♠ Paul Kelly, Marie Murphy, Pekka Oja, Elaine M. Murtagh, Charlie Foster. Estimates of the number of people in England who attain or exceed vigorous intensity exercise by walking at 3 mph. *Journal of Sports Sciences* Vol. 29,Iss. 15 2011

03

TYPES OF PHYSICAL ACTIVITY

Key terms[15]

Physical activity is defined as any movement (or force) exerted by skeletal muscle that leads to an increase in energy expenditure above rest.

Exercise is usually described as a subcomponent of physical activity that is planned and/or structured.

Training involves a clear goal of increasing performance capacity in various types of physical activity, such as in athletics.

Types of physical activity include:

- Aerobic
- Strength (resistance)
- Flexibility, core stability, balance and proprioception

Aerobic exercise is any activity that raises your heart rate and makes you slightly breathless. Walking is the most frequently undertaken aerobic activity and can be varied by intensity, duration and frequency at no cost. Other forms of aerobic exercise include swimming, aqua-aerobics, cycling and cross-training which are low weight bearing and may be more suitable for those who are unable to tolerate weight bearing exercises. Other than that, jogging and playing sport are other forms of physical activity which are usually at a moderate to vigorous intensity.

Strength (resistance) exercises are activities that improve muscle tone and strength. This can help support joints, improve posture and movement. Resistance training involves moving muscles against some form of resistance. This can be achieved by working against one's body weight or lifting everyday objects or using dumb-bells or weight-lifting machines. This may need some initial guidance through a physiotherapist or a gym instructor. The aim is to do this twice a week.

Flexibility, core stability, balance and proprioception exercise improve balance, general well-being and helps to prevent falls and injuries. These types of exercises can initially be recommended to patients under the guidance of a physiotherapist or fitness instructor. Certain exercises such as yoga, Pilates and Tai Chi can also help to improve these aspects of physical conditioning.

Physical activity does not need to be done in a gym. Daily activities such as hoovering and DIY are also considered as physical activity.

The term exercise is best avoided when talking to an inactive patient. Exercise is often associated with discomfort and sweating that requires a change of clothing and a shower! The aim is to increase ordinary daily physical activity such as walking and cycling.

04

PHYSICAL ACTIVITY **GUIDELINES**

What are the current UK physical activity guidelines?

In July 2011 all four Chief Medical Officers within the United Kingdom issued consensus guidelines[16]. These guidelines are in broad agreement with WHO, US and Canadian guidelines. The previous recommendation was 5 x 30mins of moderate activity a week. What is new since the 5x30 recommendation is:

- A stronger recognition of the role of vigorous intensity activity
- The flexibility to combine moderate and vigorous intensity activity
- An emphasis upon daily activity
- New guidelines on sedentary behaviour.

Sedentary behaviour

Many adults spend in excess of seven hours per day being sedentary and this increases with age. New evidence suggests that sedentary behaviour is adversely and independently associated with obesity, insulin resistance, Type2 diabetes, some cancers, cardiovascular disease and all-cause mortality. In other words prolonged sedentary behaviour cannot be compensated for by undertaking the 150 minutes of moderate physical activity[17,18].

Physical activity guidelines for adults

- Adults should aim to be active daily.
- Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week.
- Alternatively, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous intensity activity.
- Adults should also undertake physical activity to improve muscle strength on at least two days a week.
- All adults should minimise the amount of time spent being sedentary (sitting) for extended periods.

Muscle strengthening activities

Muscle strengthening activities have unique health benefits particularly in older adults. These include the benefits of enhancing muscle strength and the resulting improvements in functional ability and stimulation of bone formation. There are also additional benefits of resistance training on glucose metabolism and blood pressure. Ideally 8-12 repetitions of muscle strengthening activities involving all major muscle groups should be carried out two or more days a week[19].

Physical activity guidelines for elderly

- Older adults who participate in any amount of physical activity gain some health benefits, including maintenance of good physical and cognitive function. Some physical activity is better than none, and more physical activity provides greater health benefits.
- Older adults should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week.
- For those who are already regularly active at moderate intensity, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous activity.
- Older adults should also undertake physical activity to improve muscle strength on at least two days a week.
- Older adults at risk of falls should incorporate physical activity to improve balance and co-ordination on at least two days a week.
- All older adults should minimise the amount of time spent being sedentary (sitting) for extended periods.

Volume of activity

Higher volumes of activity (greater than 150 minutes per week) are associated with additional health benefits. There is insufficient evidence to determine whether there are health benefits (other than greater weight loss) beyond 300 minutes per week.

05

PHYSICAL ACTIVITY AND **CHILDREN**

- Inactive and overweight children are at higher risk of becoming obese adults[20,21], with multiple comorbidities and rising health costs. Physical activity is beneficial at all stages during formative years and active play is important in physical, mental and social aspects of growth and development[22].
- Modern day leisure activities and widespread use of technology have reduced children's daily energy expenditure compared to their grandparent's generation. High glycaemic index and high calorie fast foods are also much more readily available. The result of this equation is obvious – rising levels of childhood obesity.
- Physical inactivity is also associated with hypertension[23], metabolic risk[24], mental health[25] and reduced bone density[26] in children as young as eight years old. Hence, the message that physical activity needs to start early in childhood.

Physical activity guidelines for children[27]

Under fives

Physical activity should be encouraged from birth, particularly through floor-based play and water-based activities in safe environments.

All under 5s should minimise the amount of time spent being sedentary (being restrained or sitting) for extended periods (except time spent sleeping).

Children of pre-school age who are capable of walking unaided should be physically active daily for at least 180 minutes (3 hours), spread throughout the day.

5-18 years old

All children and young people should engage in moderate to vigorous intensity physical activity for at least 60 minutes and up to several hours every day.

Vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week.

All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.

> All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.

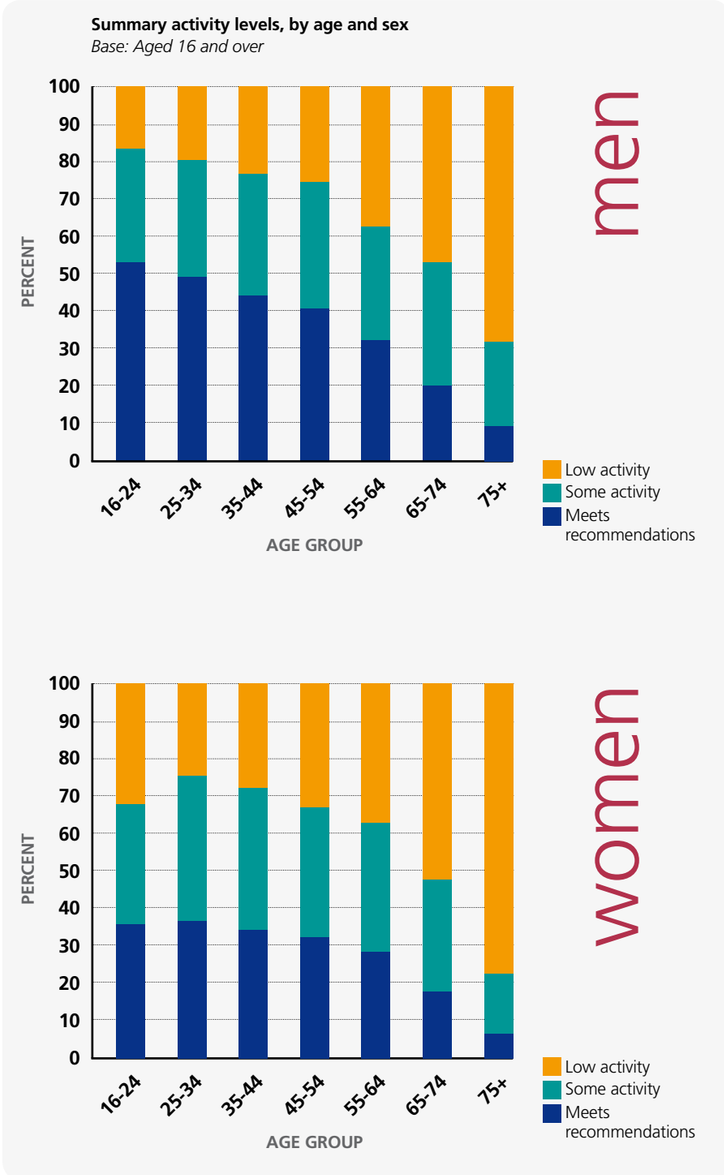
06

THE **PREVALENCE** OF INACTIVITY

How many people are inactive?

- About 66% of adults do less than 150 minutes of activity a week. However, 75% of men and 67% of women believe that they are sufficiently active[28].
- Self-reported measures of physical activity show that only 39% of men and 29% of women aged 16 and over meet the Government's recommendation for physical activity. However when an objective measure (using accelerometry) was used, the figures dropped to only 6% of men and 4% of women. The group with the highest levels of activity were those aged 16-34 showing levels of 11% and 8% respectively. *Health Survey of England 2008. NHS Information centre*
- All ages benefit from being active but the benefits are greatest in the elderly. However there is a sharp decline in activity levels after the age of 50[29] where physical activity has the greatest benefit for those who want to maintain their health and independence (Figure 4).

Figure 4: Prevalence of inactivity among adults showing a sharp decline in physical activity in the elderly (by age and sex)



07

PHYSICAL ACTIVITY AND **PRIMARY PREVENTION**

- Insufficient physical activity is the fourth leading risk factor for mortality accounting for 6% of deaths globally. This is approximately 3.2 million deaths and 32.1 million DALYs (representing about 2.1% of global DALYs) each year which are attributable to insufficient physical activity[30]. This follows high blood pressure (13%) tobacco use (9%) and high blood glucose (6%). Overweight and obesity are responsible for 5% of global mortality.

Table 4: Physical activity contribution to reduction in risk of mortality and long term conditions[31]

Disease	Risk reduction	Strength of evidence
Death	20-35%	Strong
CHD and Stroke	20-35%	Strong
Type2 Diabetes	35-40%	Strong
Colon Cancer	30-50%	Strong
Breast Cancer	20%	Strong
Hip Fracture	36-68%	Moderate
Depression	20-30%	Strong
Hypertension	33%	Strong
Alzheimer's Disease	20-30%	Moderate
Functional limitation, elderly	30%	Strong
Prevention of falls	30%	Strong
Osteoarthritis disability	22-80%	Moderate

A review of 70 papers[32] showed a reduction of mortality of 30% for the most active compared to the least active. Those with the highest fitness level had a 45% reduction in overall mortality. In one major study[33], men that became active after the age of 50 years had a 50% reduction in overall mortality. The authors note that this is greater than the risk reduction due to smoking cessation at a similar age (34%).

> If physical activity was a drug it would have wider benefits than any medication known to science and probably be recommended for every child and adult. There of course is no such drug, but physical activity does exist but is not yet available in a bottle.

08

PHYSICAL ACTIVITY, **OBESITY AND WEIGHT LOSS**

Which is the most important?

Most patients will be exercising to lose weight. This is encouraged by health professionals. However weight loss is often used as the sole marker of success of their exercise schedule. This chapter explains why this is not a good indicator.

To lose any weight 250 minutes of moderate intensity activity is required per week. This is nearly double the amount recommended in the guidelines and that is about 60 minutes of walking 5 days a week. Losing weight through physical activity alone is hard. However to maintain weight loss physical activity is essential and maybe the single most important factor to maintaining weight loss[34]. The 'Finnish twins study'[35] showed that those who lost weight from dieting had a higher risk of mortality compared to those who lost weight through increased physical activity who observed no excess mortality risk. There are three ways in which physical activity can help weight loss.

1. It directly burns off calories. An individual weighing 120kg walking for 250 minutes a week will burn off 2000 calories a week. There are 7500 kCal in one Kg of fat so it will take about a month to lose 1 Kg, assuming calorie intake remains constant.
2. It is possible to burn off more calories by increasing muscle bulk. Increasing physical activity converts fat to muscle which is more active. Muscles use up about 18% of our basal metabolic rate (BMR). The more muscle the higher the BMR and more calories expended.
3. It can help change behaviour. Being physically active may reduce the amount of calories consumed. Physical activity increases self-esteem and confidence and reduces stress so could possibly lead to less comfort eating. Physical activity is termed a 'gateway behaviour' as it leads to other behaviour changes. However the research in this area is still in its early stages and inconclusive.

How are all the other calories burnt off?

Physical activity only uses up 20-30% of our total daily energy expenditure (although athletes could burn off up to 50% of their total calories). The remaining 70-80% of calories are required to maintain the body's metabolism. This is called the basal metabolic rate or BMR which uses energy to maintain the organs including the liver (27%) brain (19%), kidneys (10%) and heart (7%). The muscles use up 18% of the total energy expenditure when resting. The BMR in kCal/ day can be calculated by the equation below[36]. For a 50 year old man weighing 80kg this equals 1555kCal.

BMR (kcal/day) = [10 x Weight (kg) +6.25 x Height (Cm) -5 x Age(years)] +5 (for males) or -161 for females

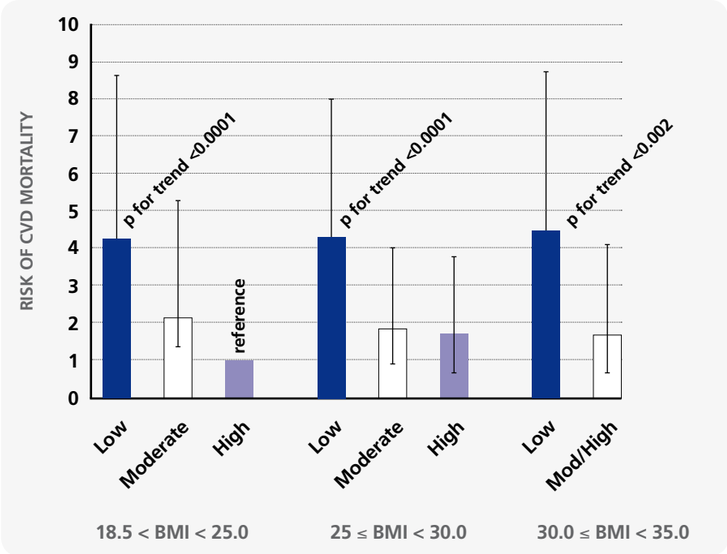
Is physical activity only beneficial because it helps patients lose weight?

The key point to tell patients is that maintaining physical activity is as important to their health than losing weight. ***Physical activity benefits health independently to obesity***. A study involving 2,316 men[37] with Type2 Diabetes were divided into three groups according to their weight. Each weight group was then divided into three groups according to their fitness. Those who were obese but with moderate to high fitness had half the risk of CVD mortality compared to those who were normal weight but unfit. Figure 5.

The results of this study show that the benefits of cardiorespiratory ***fitness are not only independent of obesity but also appear to be significantly more important***. In England 32% of men and 19% of women who are obese meet the physical activity recommendations compared to 46% of men and 36% of women who are neither overweight nor obese[38].

The 'longitudinal aerobics study' following up 14,350 men over an average of 7 years showed that those who lost weight initially showed a significant improvement in mortality[39]. However when adjusted for cardiorespiratory fitness this became non-significant. Those that increased their fitness showed a significant reduction in mortality even after adjustment. Figure 5 shows that any fall in BMI and % fat had a non-significant effect on cardiovascular and all-cause mortality. However there was a very significant trend in mortality reduction for those patients who increased their fitness.

Figure 5: Risk of cardiovascular disease mortality by cardiorespiratory fitness and body mass index categories. 2,316 men with Type2 diabetes at baseline, 179 deaths



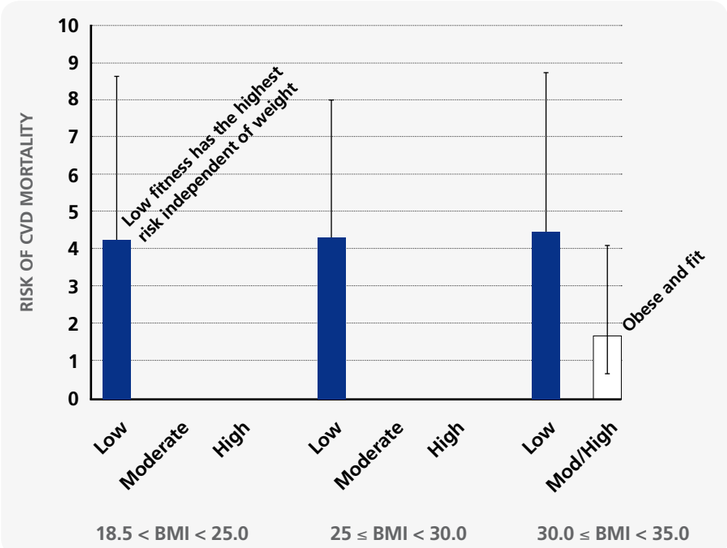


Figure 6: Effect of increased fitness on all-cause mortality

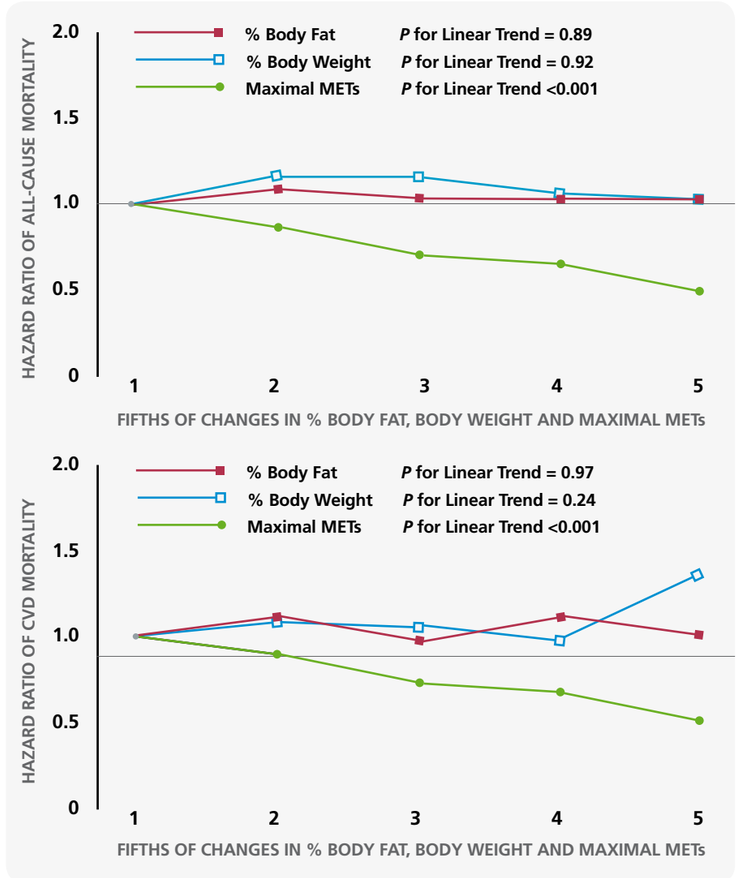
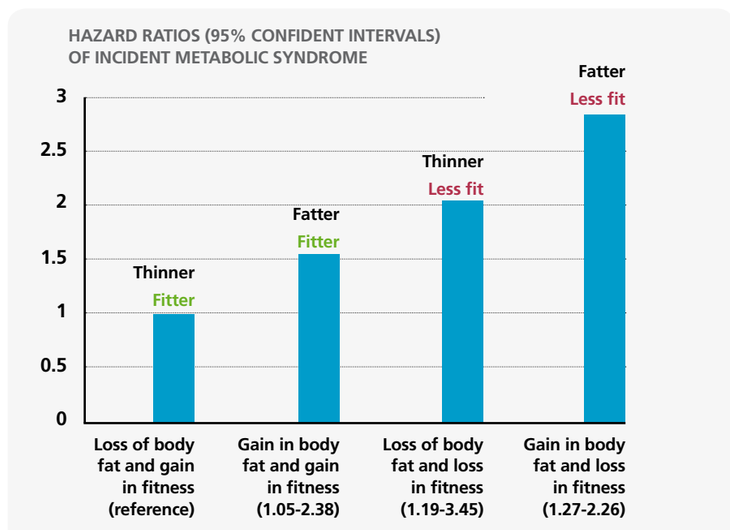


Figure 7: Changes to fitness and fatness and the effect on developing metabolic syndrome in 3148 adults followed up for 6 years and divided into groups according to whether their weight or fitness increases, remains the same or decreases



A further study[40] 3,148 healthy adults who received at least 3 medical examinations were followed up for 6 years. Fitness was determined by using a maximal treadmill test. Fatness was expressed by percent body fat and body mass index. Changes in fitness and fatness between the first and second examinations were categorized into loss, stable, or gain groups. 426 adults developed metabolic syndrome. The results show that although both increasing fatness and decreasing fitness were beneficial the loss of fitness was the more important factor and the authors found that increased fitness almost eliminated the poor health effects of increasing weight (Figure 7).

The health problems of increasing weight and obesity appear to be significantly attenuated by increasing fitness. Increasing fitness should be promoted without using weight loss as the surrogate marker of success. The evidence suggests that promoting activity (and hence increasing fitness) is now a priority over weight loss. This should now be seriously considered in all clinical guidance.

09

THE RISKS OF PHYSICAL ACTIVITY

"Is it possible that there may be a time when a lawyer cross examines a doctor in the witness stand, asking why they did not address their sick or dead patient's physical inactivity... because it is known to be one of the highest modifiable risk factors for morbidity and mortality?"[41]

- An inactive patient increases the risk of developing many chronic diseases. The active person's risk of death is reduced by a third compared to the person who remains inactive.
- The risk of a sudden cardiac death associated with moderate intensity exercise is one in 36.5 million hours of exertion[42]. Putting it another way, among people undertaking vigorous activity there is one death per year per 18,000 individuals[43].

Risk of harm when starting activity can be reduced through the following actions:

- Build up intensity slowly
- Avoid vigorous activity until fully confident
- Ensure patients understand the significance of worrying symptoms such as feeling faint or developing chest pain.

It is important to discuss risk so that the patient can make an informed decision. In all cases, starting activity slowly and building up gradually significantly reduces the risk of harm. If there is doubt then supervised exercise may be the most appropriate option to start with, and Exercise Referral may be the best option.

The BHF National Centre for Physical Activity and Health at Loughborough University is creating some key guidance for GPs to minimise the risk of advising patients to become more physically active www.bhfactive.org.uk

10

THE BRIEF INTERVENTION – MOTIVATING PATIENTS TO BECOME MORE ACTIVE

A brief intervention consists of five parts:

1 Identifying the inactive patient

2 Screening for suitability

3 Exploring how they might change their behaviour using motivational interviewing techniques

4 Helping to find suitable activities locally

5 Goal setting, feedback and reinforcement

Depending on the resources available, all or some of these tasks can be carried out by different members of the primary care team but are particularly effective when the GP is involved in at least part of the process.

1 Identify the inactive patient

This can be done in two ways and may be done while the patient is waiting for their appointment.

A GPPAQ. This is the official questionnaire from the Department of Health that is currently being used in Health Checks and may possibly be used to calculate QOF points in the future for hypertension interventions. But be aware that although patients are asked about walking, gardening and housework, none of these activities are actually used in the algorithm to calculate the level of physical activity met. So the patient walking an hour a day is said to be inactive when in fact they have easily met the guidelines. This is a problem that has yet to be resolved. GPPAQ has four possible outcomes that each has a READ CODE.

Outcome of GPPAQ	Read Code
Inactive	138X
Moderately Inactive	138Y
Moderately Active	138a
Active	138b

B The 'Single Item' question was developed by the BHF National Centre and involves a single question that has been validated to be as accurate as every other more complex questionnaire[44]. The question is:

"In the past week how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate? This may include sport, exercise, brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job."

Active = 5-7

Moderately Active = 3-4

Moderately Inactive = 1-2

Inactive = 0

2 Screen for suitability

This is best completed by the GP, who with a full understanding of the patient's medical history, will be able to provide the necessary reassurance and encouragement to the patient.

There are a few cautions and even fewer contraindications to becoming more active particularly when the first line of treatment is to just walk more. This reduces the risk and allows the patient to remain active before embarking on more advanced or structured activity. We have listed the cautions and contraindications in the chapters specific to each condition. The advice is always to start gently and build up slowly.

3 Give a brief intervention or refer to motivational interviewing

Behaviour change is difficult. First you have to establish whether the patient is ready to change their behaviour. Do they show ambivalence? Typically, a patient who is showing ambivalence might say "I would like to be become more active but..." You then have a choice.

A Refer them to someone who has motivational interview training and is used to encouraging someone to become more active. This could be a clinic in the practice or a nurse specifically trained in Motivational Interviewing.

B Provide a brief intervention yourself. You may only have 2 minutes but this will be better than nothing.

If they do not show ambivalence and unequivocally do not express any interest in being more active or desire to be more active, you are unlikely to be able to progress the discussion without first creating that ambivalence by exploring their beliefs and values around physical activity.

Giving a brief intervention without any motivational interview training

In the absence of a qualified Motivational Interviewing trainer, the GP or health professional can still help to change behaviour, or at least ensure that a patient's readiness to change is not compromised by saying the wrong thing at the wrong time. We give below an extract from a summary explaining Motivational Interviewing[45]. Although we have listed some techniques used in Motivational Interviewing it is important that the spirit of MI is understood and implemented.

The Spirit of Motivational Interviewing

MI is a collaborative, person-centred form of guiding to elicit and strengthen motivation for change.

Collaboration (vs. Confrontation)

Collaboration is a partnership between the therapist and the patient, grounded in the point of view and experiences of the patient. This does not mean that the patient is always right rather that there is a mutual respect and understanding in the discussion that follows.

Evocation (Drawing Out Vs. Imposing ideas)

The approach is to draw out their ideas and thoughts rather than imposing your opinions. This is because motivation and commitment to change is most powerful and durable when it comes from the patient. The therapists job is to "draw out" the patient's own motivations and skills for change not to tell them what to do or why they should do it.

Autonomy (Vs. Authority)

MI recognises that the true power for change rests with the patient and so it is up to the individual to follow through with making changes happen. This is empowering to the individual, but also gives them responsibility for their actions. The patient is encouraged to create a menu of options as to how to achieve the desired change.

- Motivation to change cannot be imposed.
- It is the patient's task, not the health professional's, to sort out this ambivalence.
- Direct persuasion is not an effective method for resolving ambivalence.

Principles of Motivational Interviewing

Express Empathy

This means seeing the world through the patient's eyes, feeling what they are feeling. This provides the basis for the patient to be understood and encourages a more honest conversation.

Support Self-Efficacy

The patient has to believe that they have the strength to make a difficult change. They may have tried and failed in the past so have doubts about their ability to succeed, the clinician highlights the skills and strengths that the client already has.

Roll with Resistance

Resistance occurs when there is a conflict between their own view of the problem/solution and that of the clinician or when the patient feels that their freedom or autonomy is being impinged upon. When resistance is met then in MI the clinician works to de-escalate and avoid a negative interaction, instead rolling with it. This avoids the "Yes, but" response to the clinician suggestions. The term often used is to' dance' rather than 'wrestle' with the patient. Another important but hard habit for a clinician to break is the "Righting Reflex", a tendency that is born from concern and a wanting to do the right thing for the patient i.e. solve the problem for them.

Developing Discrepancy

Motivation for change occurs when people perceive a mismatch between "where they are and where they want to be", and a clinician helps the patient examine this discrepancy between their current circumstances and their values and future goals.

A quick guide to some basic techniques used in MI:

OARS

The acronym OARS can be used as a prompt to guide the MI consultation.

- **Open Ended Questions** invite elaboration and thinking more deeply about an issue. Closed questions are still important but open ended questions are more likely to lead to behaviour change.
- **Affirmations** are statements that recognise patient strengths. They help to build a rapport and therefore see themselves in a positive light. Look out for comments such as 'I know I can do this because...'
- **Reflection** is the most crucial skill in motivational interviewing. First it allows the patient to feel that they are being understood by the clinician. Second it allows the clinician to focus on the negative aspects of the status quo and the positive aspects of change. Reflect back to the patient what they have said and expressed.
- **Summarising** helps to communicate interest, understanding and call attention to important elements of the discussion.

Change Talk

Different types of change talk can be described using the mnemonic DARN CAT.

Preparatory Change Talk

Desire (I want to change)

Ability (I can change)

Reason (It's important to change)

Need (I should change)

Implementing Change Talk

Commitment (I will make changes)

Activation (I am ready, prepared, willing to change)

Taking steps (I am taking specific actions to change)

There are some therapeutic strategies that are likely to elicit and support change talk in motivational interviewing. One such technique utilises the table below to explore a patient's decision-making process.

Explore Decisional Balance

Outcome of GPPAQ	Good	Not so good
Not Changing	1. Advantages of Status Quo	2. Downside of Status Quo
Changing	4. Advantages of changing	3. Downside of changing

Use change Ruler

Ask on a scale of 1 to 10 how important is it to you to change where one is not important and 10 is extremely important? Then say "and why are you here [number chosen] and not here [lower number. "What might happen that could move you from XX to a higher number".

Explore goals and values

Ask what the person's guiding values are. What do they want from life? Ask how not changing fits in with their goals or values.

4 Identify suitable activities locally

Chapter 11 explores some of the options for finding suitable local activities. The key point is that the patient is involved in identifying activities that they will enjoy and which they feel they will be able to sustain over a prolonged period of time.

5 Goal setting, feedback and reinforcement

It is useful to agree with the patient a goal for becoming more active. This may be as simple as 'I will go for a 20 minute walk three times next week' to a more complex goal based around a diverse training schedule. Goal setting is more effective if goals are written down and records are kept of goals having been achieved. Positive reinforcement of behaviours through praise and encouragement plays a crucial role in keeping the patient engaged. Objective measurements of change, e.g. reductions in lipid profiles or blood pressure readings can also provide positive and meaningful reinforcement.

This is a very brief review of Motivational Interviewing and certainly doesn't replace full training. Clinical Staff in the GP practice would benefit from understanding MI training. It is one approach that underpins all behaviour change including weight loss, smoking cessation and treatment compliance.

11

WHAT ACTIVITIES ARE AVAILABLE LOCALLY?

Each patient when motivated to become more active will usually need some help in choosing the most appropriate activity. In order to be sustainable the activity has to be:

- Local
- Enjoyable
- Practical

Whether this means walking to the end of the road each day, joining a health walk, taking up badminton or dance, will be entirely up to the individual. However asking a patient to do exercises they find boring or attend a venue where they do not feel comfortable is likely to lead to failure. The key drivers to maintain sustainability are social support, purpose and a supportive environment.

The first line treatment should include more walking. This is not only free but is practical and requires no skill or equipment and delivers all benefits of aerobic activity.

Walking for health

Health Walks (www.walkingforhealth.org.uk)

Most Boroughs organise a series of health walks which involves a volunteer leader taking a group on a short brisk walk.

NICE has stated that Health Walks provide considerable mental benefits to those taking part. Their review[46] provides the following advice:

- In collaboration with older people and their carers, offer a range of walking schemes of low to moderate intensity with a choice of local routes to suit different abilities.
- Promote regular participation in local walking schemes as a way to improve mental wellbeing for older people and provide health advice and information on the benefits of walking.
- Encourage and support older people to participate fully according to health and mobility needs, and personal preference.
- Ensure that walking schemes:
  - are organised and led by trained workers or 'Walking the way to health initiative' volunteer walk leaders from the local community who have been trained in first aid and in creating suitable walking routes
  - incorporate a group meeting at the outset of a walking scheme that introduces the walk leader and participants
  - offer opportunities for local walks at least three times a week, with timing and location to be agreed with participants
  - last about 1 hour and include at least 30–40 minutes of walking plus stretching and warm-up/cool-down exercises (depending on older people's mobility and capacity)
  - invite regular feedback from participants and use it to inform the content of the service and to gauge levels of motivation.

Walking for Health is suitable for those who are on their own and lack the confidence or local knowledge to go for a walk on their own. Every GP practice should have a Health Walk nearby. If not available locally, the surgery should contact the local physical activity co-ordinator based within public health at the local authority who may be able to help set one up from the surgery each week.

Exercise Classes

These can be organised by the local authority at the local leisure centre or by fitness instructors in school halls and local parks. Dance, Zumba, aerobics and spinning are all popular, fun and provide a great social interaction.

The aim is to give the patient a new lease of life where they meet people and just enjoy themselves. (Physical activity is just a useful by-product).

Exercise Referral

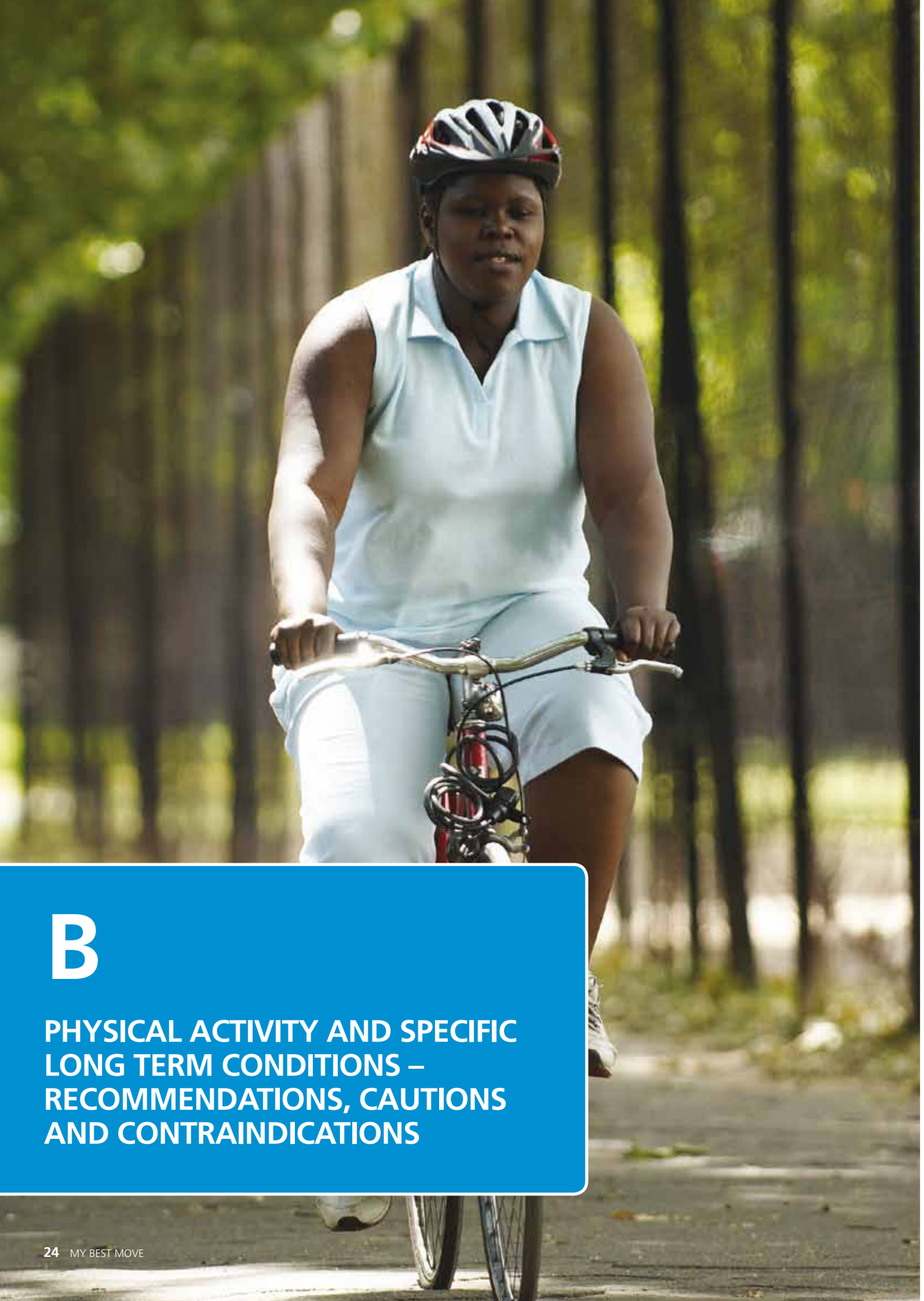
Most Boroughs have an exercise referral scheme that is usually gym-based and accessed by GPs using a referral form. The criteria for referral usually include patients with clinical conditions such as obesity, depression, hypertension and post cardiac rehabilitation. These patients are offered an eight week programme in the gym for free. After the programme has finished the patient is encouraged to continue although the sessions are no longer free.

A recent major Systematic Review funded by the NHS had the following conclusion concerning Exercise Referral Scheme (ERS)[47]:

"In 2006, NICE commented that there was insufficient evidence for ERS and recommended that the NHS should only make ERS available as part of a controlled trial. Although we have identified four additional trials since the NICE review, there remains very limited support for the potential role of ERS for impacting on physical activity and, consequently, public health... little evidence was found of how the ERS intervention sought to develop a sustainable active lifestyle in participants, as recommended in the NHS National Quality Assurance Framework."

"Although ERS programmes in our review aimed to increase medium- to long-term physical activity, they were typically based on only a 10- to 12-week leisure centre-based period intervention. With the exception of one trial (Jolly K, Duda JL, Daley A, Ntoumanis N, Eves F, Rouse P, et al. An evaluation of the Birmingham exercise on prescription service: standard provision and a self-determination focused arm. Final Report; 2009), there was minimal reference to health behaviour change techniques and theories that typically underpin interventions to promote an increase in daily physical activity."

This calls into question the widespread use of exercise referral schemes. Maintaining physical activity involves activity as part of a normal routine or activities that are rewarding and provide a very positive experience.



B

PHYSICAL ACTIVITY AND SPECIFIC LONG TERM CONDITIONS – RECOMMENDATIONS, CAUTIONS AND CONTRAINDICATIONS

12

CANCER AND PHYSICAL ACTIVITY

Summary

- Physical activity has a strong protective effect against colon, breast, and endometrial cancers and a moderate effect against prostate lung and ovarian cancer.
- More recent research has shown that regular physical activity before and after cancer diagnosis not only improves function and wellbeing but significantly improves survival.
- 90 minutes of brisk walking a week appears to be the minimal activity to create most of these benefits.
- Physical activity does not cause excessive tiredness in those patients undergoing treatment.

Minimal work-up before recommending physical activity

History and examination to determine:

1. What stage of cancer. Where is / are the tumours spread? (risk of pathological fracture)
2. Any radiotherapy treatment, chemotherapeutic or other drugs being used?
3. Any concomitant diseases? E.g. anaemia, osteoporosis
4. Concomitant heart or lung disease, either through disease, treatment or as a separate co-existant disease
5. If shortness of breath is present, determine the cause, precipitating activity and tolerance

Investigation:

Guided by history and examination, full blood count.

Recommendations for physical activity (see also Chapter 4 – UK Guidelines)	
Frequency	Daily
Intensity	Moderate
Type	Aerobic – walking, cycling, swimming, resistance – body weight, proprioception and balance, e.g. Tai Chi
Time	Minimum of 10 minutes gradually increasing to 30 minutes a day but adapted to individual's age and fitness level

Cautions and contraindications

29 out of 36 studies found no adverse effects caused by physical activity during cancer treatment. Of the 201 adverse events reported only 5 were attributable to physical activity and these were minor self-limiting musculoskeletal problems and an increased blood pressure.

Immunosuppression
Patients with a white cell count below 0.5 $x10^9$/l are advised to refrain from high intensity or endurance activities.

Anaemia
Patients with an Hb < 8.0 g/dl should refrain from high intensity activities

Thrombocytopaenia
Patients with platelets <50 x 10^9 should refrain from contact sports.

Bone metastases
These patients should avoid high impact and contact activities. However light to moderate activity in these patients appears to be safe[48].

Patients with breast cancer are worried about the exacerbation of lymphedema with upper body exercise. However upper body resistance exercise was tolerated in breast cancer survivors with no adverse effect on lymphedema[49,50].

Physical activity during treatment (chemotherapy, radiotherapy and hormone therapy)

Most patients are told to rest during chemotherapy to avoid fatigue[51]. This is usually a compassionate response to the patient's condition. However there is no evidence to support this advice and it may exacerbate the treatment-related losses of physical conditioning and muscle strength leading to a perpetual cycle of deteriorating function and accumulating fatigue that is very hard to escape[52].

A systematic review and meta-analysis showed that patients who are more physically active during chemotherapy, radiotherapy and hormone therapy are no more tired than those that rest[53]. In fact the same review shows that being more active increases physical fitness and strength, muscle bulk and wellbeing.

How can physical activity help prevent cancer?

Table 5: The percentage risk reduction and strength of the evidence of physical activity's role in helping prevent certain cancers

Cancer type	% reduction	Strength of evidence	Notes
Breast[54,55,56]	20-50	Strong	Particularly for post-menopausal women
Colon[57,58,59,60]	30-50	Strong	Physical activity reduces time carcinogen in contact with bowel wall
Endometrial[61]	20-30	Strong	
Prostate[62,63]	10-20	Moderate	Reduces effect of testosterone
Lung	20-40	Moderate	
Ovarian	20	Moderate	
Others			Weak evidence

How can physical activity treat cancer survivors?

Cancer survivors often improve their diet and stop smoking after diagnosis but physical activity levels are reduced significantly[64,65].

Breast Cancer

"Evidence supporting the benefits of exercise following the diagnosis of breast cancer is overwhelming and compelling". A systematic review in patients with the diagnosis of breast cancer showed that physical activity may be associated with 41% reduced all-cause mortality, 34% fewer breast cancer deaths and 24% reduced risk of disease recurrence[66]. A further review supported these findings[67]. It also reduces hospitalisation, anxiety and side effects such as nausea, lymphedema, fatigue and pain[68].

Results of the two largest studies suggested that women reaching the equivalent of the recommended minimum levels of physical activity (i.e. 150 minutes of moderate-intensity activity per week) had over 40% lower risk breast cancer-specific mortality, and breast cancer recurrence, compared with women active for less than one hour a week[69,70].

All women diagnosed with breast cancer can benefit from physical activity and risk of adverse events and poorer quality of life are higher in those who do not exercise. Those that decrease their levels of activity after diagnosis have a fourfold greater risk of mortality[71].

Colorectal cancer

Results of two studies suggested that risk of disease recurrence, cancer mortality was reduced by about 50%, by performing the equivalent of six hours of moderate intensity physical activity per week[72,73]. If patients are already doing just one session of activity a week at diagnosis it improves cancer specific 5-year survival to 73% compared to 61% for those less active[74].

Prostate Cancer

Findings from two studies indicated a lower risk of prostate-specific mortality of approximately 30%[75] and a lower rate of disease progression of 57%[76] with three hours per week of moderate intensity physical activity (e.g. brisk walking). Some vigorous activity appeared to add further benefits to reduce death specifically from prostate cancer.

For possible mechanisms for how physical activity can help treat and prevent cancer, see Chapter 20.

13

OSTEOARTHRITIS AND PHYSICAL ACTIVITY

Summary

- Regular moderate physical activity not only helps to prevent the development of osteoarthritis (OA) but also reduces pain and increases function in patients with existing hip or knee osteoarthritis.
- 150 minutes a week of low impact activity such as walking is recommended. Patients with OA tend to be very inactive. In some studies only 8% achieve these guidelines and over 57% of women with OA do not even complete 10 minutes of activity a week.
- Many patients think that rest is better for their joints because of the association of joint pain with increased activity. This belief may be reinforced by the widespread term of 'wear and tear'. It is better to use the term 'wear and repair'.
- Moderate activity increases the quality of cartilage and muscle strength. There are no contraindications to moderate strengthening or aerobic exercise.
- Frequent participation in high impact sports can increase the risk of developing OA.

Minimal work-up before recommending physical activity

History and examination[77]:

- Determine the stage and severity of arthritis. Elicit and understand how OA affects the patient's life and how they are currently self-managing.
- Agree with patient's goals they would like to set and how they are going to achieve them.
- Those individuals with recently diagnosed arthritis disease or those experiencing significant pain should be prescribed gentle physical activity or pool-based exercise.

Recommendations for physical activity	
Frequency	Daily
Intensity	Mild to moderate e.g. walking (see chapter 4)
Type	Aerobic – large muscle group activities e.g. walking, cycling, swimming Resistance, balance, proprioception and flexibility – e.g. yoga, Tai chi, referral to physiotherapy and through the gym Both resistance and aerobic activity can benefit osteoarthritis. In one systematic review walking was more effective than quadriceps strengthening exercises in reducing pain and disability[78]. (See Table 6 and note that an effect size of 0.2 is small, 0.5 is moderate and 0.8 is large.) Water based exercise has been shown to be less efficient in reducing pain and improving muscle function than land-based exercise although it may be more suitable[79] for obese patients[80] or those limited by pain or function.
Time	150 minutes a week, starting with 10 minutes a day and building up slowly
Cautions and contraindications	
There are no contraindications.	
Cautions include patients who are at risk of falling particularly those starting to be active after a long period of inactivity and hence with weak muscles and poor proprioception.	

Table 6

Type of activity Pooled effect size	Aerobic Walking	Quadriceps Strengthening
Pain	0.52	0.39
Disability	0.46	0.32

Investigation:

- Only X-Ray a hip or knee if there is uncertainty about the diagnosis or the patient has been referred for arthroplasty.

How can physical activity prevent or initiate osteoarthritis?

- There is good evidence that people who undertake moderate PA have a lower risk of developing osteoarthritis[81].
- Excessive vigorous activities such as rowing, skiing or long distance running can increase the risk of osteoarthritis due to micro-trauma to the cartilage[82]. Likewise any injuries to either knee or hip can induce osteoarthritis.

How can physical activity treat osteoarthritis?

- Several systematic reviews have demonstrated that physical activity reduces pain and increases function in both hip and knee osteoarthritis[83,84,85,86].
- In one study of 1000 patients only 13% of men and 8% of women with knee OA were undertaking enough physical activity to meet the guidelines. 40% of men and 57% of women were totally inactive. (i.e had undertaken no moderate activity of 10 minutes or more during the past 7 days[87].)
- The effect of physical activity on pain is similar to the treatment of NSAID[88]. When asked, most patients would prefer to treat their osteoarthritis with exercise compared to being treated with an NSAID[89,90].
- Patients need to be told that starting physical activity may initially cause pain but that this does not equate to damage. The pain may improve over time as the muscles strengthen and the joint stabilises.
- The Arthritis Research leaflet[91] helps GPs interpret the data for patients 'If we take 100 people like you with knee OA, then without treatment 33 people are going to have less pain after 2 years but 67 won't. However, with exercise an extra 12 people will have less pain after 2 years but 55 still won't'. Unfortunately we don't know which 12 will benefit!

14

LOW BACK PAIN AND PHYSICAL ACTIVITY

Summary

- 40% of the population have reported a back pain complaint lasting more than one day in the previous 12 months of whom 40% consult their GP and 5% take time off work in the previous month[92]. The total cost of primary care related to back pain in 1998 was £140.6 million[93].
- Stage of lower back pain can be classified into: Acute (< 4 weeks), sub-acute (4-12 weeks) or chronic (>12 weeks).
- General aerobic physical activity can both prevent and treat acute, sub-acute and chronic low back pain.
- The goal when treating low back pain is to help the patient become fully active, pain free and return to normal (work) as soon as possible.

> Complete bed rest should be avoided in all cases of low back pain as it delays recovery and causes muscle atrophy.

Minimal work-up before recommending physical activity

1 Identify where possible the cause of back pain. 90-95% of patients have 'nonspecific' low back pain with or without associated muscle spasm. The specific causes are:

- **A** Disc hernia
- **B** Spinal stenosis
- **C** Spondylolisthesis
- **D** Inflammatory back disorder
- **E** Disc degeneration and osteoarthritis
- **F** Osteoporotic fracture
- **G** Malignancy
- **H** Infection

2 Determine stage of lower back pain (acute, sub-acute or chronic) as this can help recommend type of activity prescribed.

Recommendations for physical activity	
Frequency	Daily
Intensity	Mild to moderate (see Appendix II)
Type	Aerobic – large muscle group activities e.g. walking, cycling, swimming is the mainstay of activity. Muscle strengthening, balance, proprioception and flexibility – e.g. yoga, Tai chi, referral to physiotherapy and through the gym. Extensor exercise of the trunk, where musculature on one side of the spine is activated at a time (i.e. such as when kneeling on all fours and extending one leg at a time) is preferred over regular trunk extension exercise as it reduces lumbar spine loading[94]. For patients with acute low back pain, flexion and/or extension that does not cause pain, combined with heat wrap may be beneficial[95].
Time	To start with, 10 minutes a day and build up slowly to the recommendations of 150 minutes of moderate activity.

Cautions and contraindications

Cautions

- The following patient group may require specialist input (physiotherapist, Sport and Exercise Medicine Specialists) and medical treatment as exercise may be contraindicated:
  - Recent back surgery
  - Nerve root compression
  - Fracture
  - Neurological symptoms
  - Spondylolisthesis
  - Inflammatory and infectious conditions
- Full sit-ups should be avoided as this places too much loading on the lumbar spine[96].
- Lumbar flexion exercises just after rising from bed should be avoided, as intervertebral discs imbide fluid overnight, leaving them susceptible to higher stresses when loaded[97].
- Loading the lumbar spine after prolonged sitting should be avoided, as ligament laxity increases with long periods of sitting[98].

Contraindication

- Absolute contraindication to physical activity is when the stability of the spine is endangered by a normal load caused by spondylolisthesis, a malignancy, metastasis or fracture.

How can physical activity prevent low back pain?

Primary prevention

- There is good evidence that physical activity can prevent low back pain in asymptomatic individuals[99,100].

  Low physical activity is one of the risk factors for accelerated development of disc degeneration[101].

Secondary prevention

- There is moderate evidence that physical activity can prevent further recurrence of low back pain.

How can physical activity treat low back pain?

Acute low back pain

- There is no evidence that specific exercise therapy reduces pain or disability in acute back pain more than placebo or other conservative treatment[102,103,104,105,106,107,108,109]
- However several major reviews confirm that the patient should be advised to start low impact aerobic activities (walking, swimming or cycling) within the first two weeks[110].
- Bed rest and inactivity should be avoided as this causes significant muscle atrophy around the spine that can eventually lead to increased pain and instability[111].

Subacute back pain

- There is limited evidence that exercise therapy is effective in improving pain and functional status in patients with non-specific sub-acute low back pain compared to no exercise comparisons[112,11,12].
- In a one high quality RCT in an occupational setting graded exercise appeared to be the most effective with reducing time off work although pain and functional status were not improved statistically[113].

Chronic back pain

- There is strong evidence that exercise therapy has a small effect in improving pain and functional status in patients with non-specific chronic low back pain[114,115].
- A Cochrane review of 43 trials showed that exercise therapy was at least as effective in improving pain and functionality as other conservative measures. Successful interventions tended to be individually designed and delivered[116]. However in some studies general physical activity is superior to back exercises[117].
- There appears to be no difference as to whether the exercise is delivered in groups compared to individuals[118,119,120] although personal supervision improves the outcome of the exercise programme[121,122,123].

Notes on treating some specific back pain

Spondylolisthesis

- Cycling may be preferable for patients with spondylolisthesis because flexion of the spine opens up the spinal cord[124].
- Core stability exercises are recommended for patients with spondylolisthesis[125].

Sciatica

- Being physically active offers no advantage in pain and function during the acute phase of sciatica compared to rest[126]. However starting physical activity within the first two weeks can help improve recovery and lessen disability.

Low back pain in pregnancy

- NICE guidelines suggest women should be informed that exercising in water, massage therapy and group or individual back care classes might help to ease backache during pregnancy[127]. Aquatic exercise, low impact aerobics, acupuncture and pelvic muscle exercises are reported to be effective in reducing pain, disability and the number of sick days.

Post lumbar disc surgery

- Exercise programmes starting four to six weeks post-surgery lead to a faster decrease in pain and disability than no treatment. High intensity exercise leads to faster decrease in pain than low intensity. There is no difference between supervised and home exercises for short term pain relief. Activity does not lead to an increase in re-operation rate[128].

NICE Guidelines for physical activity and chronic low back pain

What type of general physical activity is recommended?

NICE Guidelines[129] on Chronic Low Back Pain recommend the following:

Advise people with low back pain that staying physically active is likely to be beneficial.

Consider offering a structured exercise programme tailored to the person:

- This should comprise up to a maximum of eight sessions over a period of up to 12 weeks.
- Offer a group supervised exercise programme, in a group of up to 10 people.
- A one-to-one supervised exercise programme may be offered if a group programme is not suitable for a particular person.

Exercise programmes may include the following elements:

- aerobic activity
- movement instruction
- muscle strengthening
- postural control
- stretching.

15

CARDIOVASCULAR DISEASE AND PHYSICAL ACTIVITY

Summary

- Physical inactivity carries a similar risk of cardiovascular disease as smoking and hypertension.
- 150 minutes of moderate activity a week with or without vigorous activity can reduce the risk of CAD by 22% in men and up to 33% in women.
- Following a cardiac event all should be invited to participate in Cardiac Rehabilitation, however currently only 38% of eligible patients participate.
- Almost all inactive patients with CVD should be able to participate in some activity by starting at 10 minutes walking a day and then slowly introducing other activity, resistance training and potentially vigorous activity. It is important to educate the patient about the warning signs of faintness, chest pain etc. which need immediate follow up.

Recommendations for physical activity[130]	
Frequency	Daily
Intensity	Exercise should be performed to at least moderate intensity and vigorous intensity activity should be added if possible and when required.
Type	Aerobic activity such as walking, jogging, cycling, swimming, rowing, stair climbing, elliptical trainers, aerobic dancing etc. In addition the ACSM advises strength training two days a week with a weight that allows for 8-12 repetitions per major muscle set[131].
Time	To start with, 10 minutes a day and build up slowly to the recommendations of 150 minutes of moderate activity[132].

Patients who have made an uncomplicated recovery after their MI can resume sexual activity (2-4 METS[133]) when they feel comfortable to do so usually about 4 weeks[134].

Cautions and contraindications

Contraindications to promoting an increase in physical activity, taken from the ACSM guidelines for exercise testing[135].

- Unstable angina
- Severe valvular stenosis or regurgitation
- Active myocarditis or pericarditis
- Ventricular tachycardia (uncontrolled)
- Decompensated heart failure
- BP >200/115
- Other clinical entities known to worsen during exercise.

Minimal work-up in patients with existing CVD before recommending physical activity

History and examination:

For those who have existing CVD then a careful history should identify:

- Existing symptoms of angina, claudication and shortness of breath, particularly when experienced at rest.
- How much activity the patient is already undertaking and whether this brings on chest pain, faintness, shortness of breath palpitations or other symptoms.
- Identify previous cardiac events and ask whether this was followed up with an uneventful cardiac rehabilitation.
- Ask about other co-morbidities such as diabetes, COPD and arthritis and whether these conditions are stable.

Examination should seek to identify

- severe hypertension
- heart failure
- valvular disease (stenosis or regurgitation)
- arrhythmias.

With low risk patients clinicians should use their clinical judgment as to whether patients require further investigation particularly if the patient is keen to re-start vigorous activity.

Intermediate risk patients require a resting ECG and may require referral for further investigations before increasing their activity particularly if this includes vigorous activity. Promoting walking is likely to be safe.

High risk patients require referral to the cardiology department or a sports and exercise clinician before starting an exercise regime.

How can physical activity prevent cardiovascular disease?

Physical activity reduces the risk of cardiovascular disease with a magnitude of risk reduction comparable to that of reducing hypertension and quitting smoking[136,137,138]. More than 25% of the population-attributable risk for MI is due to physical inactivity compared to 13% due to diet[139].

If the total amount of physical activity exceeds 1000kCal per week (brisk walking for 180 minutes a week) then the risk of developing CAD is reduced by 22% for men[140,141], and up to 33% for women[142].

There is a dose response for CVD mortality reduction so that even a small amount of activity makes a considerable difference in mortality[143]. The greatest benefits are moving from inactive to undertaking 60 minutes moderate activity a week. Above 300 minutes a week, aerobic fitness is a better predictor of cardiovascular mortality than self-report of physical activity[144] with a 19% fall in CVD mortality for every 1 MET increase in cardiorespiratory fitness[145].

Men who become active (from being inactive) at 50 years old have a 49% reduction in mortality at the age of 60 years compared to those who remained inactive[146]. This is actually a greater benefit than for those who stopped smoking at the same time (36% reduction). Similar results are found in women who become active later in life[147].

Physical activity is known to have a modest effect on individual risk factors such as blood glucose (mean reduction of HbA1c of 0.8%[148]), lipids (HDL raised by 2.5mg/dl[149]), blood pressure (reduction of 3.4/2.4 mmHg[150]) and obesity (6.7kg weight loss/year[151]).

In addition physical activity reduces the pulse rate through increased vagal tone. This increases the amount of time it takes to fill the ventricle so increasing stroke volume which when combined with a reduction in blood pressure reduces the amount of oxygen required by the heart[152].

However newer mechanisms explained in chapter 20 such as anti-inflammatory, endothelial dysfunction and reduced reactive oxidative species (free radicals) appear to be more important and explain the large benefits of regular physical activity on cardiovascular disease.

How can physical activity treat cardiovascular disease?

Secondary prevention

Secondary prevention includes treating patients following a myocardial infarct, coronary intervention, heart failure or persistent angina. Most patients will be referred to cardiac rehabilitation initially and then discharged with the advice to continue physical activity.

Cardiac rehabilitation

The WHO definition of cardiac rehabilitation is *'the sum of activity and interventions required to ensure the best physical, mental and social conditions so that patients with chronic or post-acute cardiovascular disease may, by their own efforts, preserve or resume their proper place in society and lead an active life.'*[153]

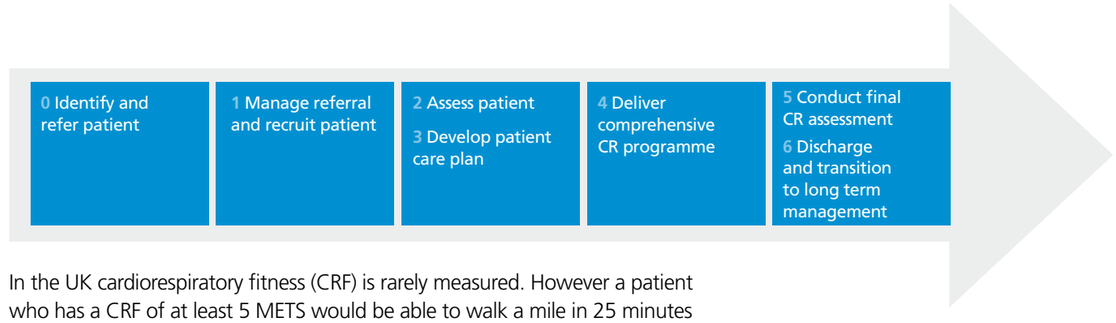
Cardiac rehabilitation in patients after MI reduces all-cause and cardiovascular mortality by 20-30% provided it includes an exercise component. Cardiac rehabilitation is both safe and cost effective.

Cardiac rehabilitation (CR) should not be regarded as an isolated form or stage of therapy, but be integrated within secondary prevention services. Evidence suggests that home- and centre-based cardiac rehabilitation appear to be equally effective[154].

NICE Guidelines on implementing cardiac rehabilitation

(NICE post MI guidance 2007)

- The National Audit of Cardiac Rehabilitation (published in 2009) reveals that of those eligible, only 38% (51,232) participated in a cardiac rehabilitation programme.
- Those more likely to be under-represented in CR include women, elderly, those from black and minority ethnic groups, from lower socioeconomic groups, from rural communities and those with mental and physical health comorbidities[155].
- Uptake of cardiac rehabilitation programmes can be improved by motivational communication such as written letters or conversation with a healthcare professional or help from lay volunteers.
- Co-ordination between primary and secondary care to encourage patients to see the practice nurse improves uptake.
- A home based programme for patients such as the validated Edinburgh Heart Manual is recommended for those who wish to remain at home.
- In the past CR was divided into phase 1-4. It is now divided into 6 sections of a best practice care pathway developed by Department of Health[156].



In the UK cardiorespiratory fitness (CRF) is rarely measured. However a patient who has a CRF of at least 5 METS would be able to walk a mile in 25 minutes comfortably. Patients with CVD can therefore be divided into low, intermediate and high risk. High risk patients are those who are either medically unstable or totally inactive irrespective of other factors.

Cautions

The Canadian systematic review[157] suggests that three factors consistently affect the risk of acute exercise precipitating a CV event:

1. Medical stability
2. Current physical activity participation
3. Aerobic fitness.

The literature on exercise testing has documented a low event rate for patients who are currently active and for patients with an aerobic power greater than 5 METs[158,159].

Table 7: Calculating the risk of a cardiac patient in primary care either post cardiac rehabilitation or whose cardiac condition does not warrant cardiac rehabilitation[199]

		Low Risk	Intermediate Risk	High Risk
1	Medically stable	Yes	Yes	No
2	Number of times a week that the patient can walk for 20 minutes without eliciting symptoms	3 or more	1-2	Inactive
3	CRF >5 METS (can walk a mile in 25 minutes)	Yes	No	
4	Age	<75yrs	>75yrs	

- Low risk patients can safely undergo moderate physical activity without further investigations based on clinical judgement.
- All high risk patients need to be referred for further assessment before the patient can undergo any further exercise.
- The clinician should use his or her judgement to decide whether intermediate risk patients need any further investigation. This will depend on other co-morbidities and the type of activity.

The incidence of cardiovascular non-fatal and fatal events is very low, being 1/50,000 and 1/750,000 person hours of supervised exercise or 1 sudden death per 15 000 to 18 000 participants[160]. The risk can be decreased by paying attention to new symptoms and gradually increasing the intensity of the physical activity. The risks of exercise are considerably outweighed by the potential benefits.

16

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) AND PHYSICAL ACTIVITY

Summary

- Physical activity is the strongest predictor of mortality in patients with COPD and exercise training (pulmonary rehabilitation) can help improve functional capacity and quality of life.
- When exercise training is provided as part of a pulmonary rehabilitation programme after a COPD exacerbation, only four patients need treatment to avoid a further admission and only six to prevent a death[161].
- Encouraging even the smallest increase in daily levels of physical activity can incur significant benefits for patients with COPD.
- There is still debate as to whether MRC breathlessness scale is the best way to identify which patients to refer to PR. The current BTS guidance is to offer patients with MRC 3, 4, 5 to PR and those with MRC 1 and 2 for general exercise programmes.
- However national guidelines (BTS and ATS/ERS) are likely to move away from MRC scale and instead recommend PR to patients who consider themselves to have functional impairment and who wish to undergo supervised pulmonary rehabilitation.
- 'Post PR': Once a patient has completed a course of PR, they should be encouraged to maintain their exercise regime as well increased physical activity and will usually be directed by their therapists towards a the most suitable activities available locally. Encouraging patients to join a British Lung Foundation (BLF) 'breathe easy' group can help people gain the peer support that is often necessary to maintain physical activity.
- Where there is no formal exercise programme the physician can use clinical judgement to recommend moderate intensity exercise (e.g. light walking) for a total of at least 20-30 minutes a day broken down into bouts of 10 minutes.

Minimal work-up before recommending physical activity

History and examination:

For those who have existing CVD then a careful history should identify:

- Determine current symptoms and functional impairment.
- Determine smoking status.
- Look for comorbidities e.g. cardiovascular disease, peripheral vascular disease, lung cancer, diabetes mellitus, hypertension, osteoporosis, which may affect the recommendation of activity levels.
- Determine contraindications to exercise. Please see below under cautions and contraindications.
- Examination should be undertaken to determine the presence of signs of pulmonary hypertension, right ventricular hypertrophy or cardiac failure.

Investigation:

- Supervised exercise capacity testing is available through most pulmonary rehabilitation services.
- Patients with significant hypoxaemia (SpO2<90%) at rest and desaturation on exertion or pulmonary hypertension should be optimally medically managed before starting exercise

.

Recommendations for physical activity in patients with COPD	
Frequency	Daily
Intensity	Moderate (see page 9)
Type	Aerobic: walking, cycling or swimming Resistance, balance, proprioception and flexibility. (see page 10)
Time	15 minutes a day if starting and build up slowly to between 20 and 30 mins a day. See DH Guidelines in Chapter 4.

MRC Scale 1-5

1 Not troubled by breathlessness except on strenuous exercise

2 Short of breath when hurrying or walking up a slight hill

3 Walks slower than contemporaries on the level because of breathlessness, or has to stop for breath when walking at own pace

4 Stops for breath after about 100 m or after a few minutes on the level

5 Too breathless to leave the house, or breathless when dressing or undressing

If the recommended levels of physical activity cannot be achieved for various medical and personal reasons, doing some physical activity, even if it is less than the recommended guidelines, may provide some health benefits[29].

Cautions and contraindications

Cautions

Patients with MRC scores of 4 or 5 benefit from PR despite their disabling breathlessness. In order to optimise a patient prior to PR and to ensure a safe programme, people with these MRC scores should have an assessment by a COPD specialist.

In patients with an MRC score of 3 it is important to consider co-morbidities and cardiac stability before recommending exercise or PR but they do not routinely need referral to see a specialist. A Canadian systematic review indicated caution due to the high risk of cardiac co-morbidity. In particular the following patients are seen as high risk and should also be considered for referral for assessment before becoming increasingly physically active[162].

- Those with a resting O_2 Saturation of 90% (or desaturation when exercising <88%)

All patients with an MRC score 3 or more should have an annual assessment of oxygen saturation in primary care. Those with values <92 % at rest may benefit from long term oxygen therapy or ambulatory therapy to help them exercise and should be referred

- Diagnosis of Pulmonary Hypertension
- Cardiovascular contraindications
- Current Smoker: Support to stop smoking is THE treatment for COPD and is both clinically and cost effective when provided in the right way. Provide COPD patients with at least 90 minutes of stop smoking support each year and suitable medicines to help reduce cravings.

Contraindications

There is no direct evidence of contraindications of activity in patients with COPD except when acutely unwell. However the clinician should be aware of possible contraindications related to the common co-morbidities particularly cardiovascular disease.

How physical activity can treat COPD	
Functional Capacity	Low levels of physical activity are associated with a low FEV1 [163,164,165,166,167,168,169,170,171]
	Physical activity reduces FEV1 decline and therefore slow disease progression[172]
	Higher FEV1 values are associated with 30 min of walking every day[173]
	Reduced physical activity can occur in COPD patients with minimal abnormality in FEV 1[174]
Exacerbations and Hospital Admission	Patients who are more active are less likely to be admitted to hospital[175,176,177]
	Less than 2 hours of physical activity per week is a significant predictor (OR: 0.60) of hospitalizations in patients with severe COPD[178]
Dyspnoea	Increased physical activity is associated with reduced symptoms of dyspnoea[179,180]
Co-morbidities	Only 6% of COPD patients do not have co-morbidity with the average patient having 3.7 conditions including COPD[181]
	COPD patients who report lower levels of physical activity have more comorbidities (cardiac dysfunction, diabetes, joint problems, osteoporosis, CHD, cataracts and glaucoma) than those with moderate or high levels of physical activity[182,183,184]
Mortality	Physical activity is the strongest predictor of all-cause mortality in patients with COPD. (inactive Vs active; Hazard Ratio=0.46 [CI 0.33-0.64])[185]
Quality of Life	There is a strong association between levels of physical activity and quality of life[186,187]

Mechanisms

Aerobic training is beneficial for patients with COPD through the following mechanisms[188]:

- Increased oxygen uptake and endurance capacity
- Decreased minute ventilation (VE), heart rate, dyspnoea, blood lactate and hyperinflation
- Improvement of oxygen extraction from skeletal muscle

Strength training is beneficial for patient with COPD through improved muscle strength and endurance.

Pulmonary Rehabilitation (PR):

It is estimated that about 40% of a GP COPD register would be suitable for PR. It is best to avoid over-emphasis on the word "exercise". Expert patients can also help (for example www.myhealth.london.nhs.uk breathe easy pages). Let them know it will make them "Breathe better, feel good, do more".

Referral to, and timely availability of pulmonary rehabilitation in the post hospitalisation setting has been shown to reduce the three month readmission rate in COPD from 33% to 7% and a cost per QALY of £13,000. To date this is the only intervention that has been shown to alter the very high 3 month readmission rate seen in COPD. The proportion of patients re-admitted to hospital with an exacerbation was 33% in the usual care (UC) group compared with 7% in those receiving post-exacerbation PR (PEPR). (OR 0.15, 95% CI 0.03 to 0.72, p=0.02). The proportion of patients that experienced an exacerbation resulting in an unplanned hospital attendance (either admission or review and discharge from the emergency department) was 57% in the UC group and 27% in those receiving PEPR (OR 0.28, 95% CI 0.10 to 0.82, p=0.02)

Positive outcomes of Pulmonary Rehabilitation

- Decreased exertional dyspnoea and dyspnoea associated with daily activities
- Increased exercise performance
- Improved health-related quality of life
- Enhanced functional status
- Reduced health care use
- Patients often consider it changes their life – it encourages them to confront fears and to make changes in their behaviour.

17

DIABETES MELLITUS AND PHYSICAL ACTIVITY

Summary

- Physical activity benefits patients with pre-diabetes (impaired glucose tolerance and impaired fasting glucose), type I and type II diabetes.
- In those patients with pre-diabetes, increased physical activity and a good diet can reduce the incidence of type II diabetes by 58% compared to 31% for those individuals taking metformin[189].
- There is clear evidence from type ii diabetes prevention clinical trials that healthy lifestyle change can prevent the development of type II diabetes in a cost effective manner in high risk individuals[190].
- For individuals with type II diabetes, there is strong evidence that physical activity can reduce HbA1c by approximately 0.6% even without associated weight loss[191] and can lead to reduced medication.

Minimal work-up before recommending physical activity

History and examination:

Up to 20% of those with newly diagnosed subjects with Type2 Diabetes have Coronary Heart Disease (CHD). Therefore it is advised to:

1. Identify asymptomatic cardiovascular disease signs and symptoms e.g. chest pain, dizziness, palpitations, dyspnoea, peripheral vascular disease (Doppler pressures measured) and microvascular complications.
2. Identify poorly controlled glycaemia (episodes of hypoglycemia and hyperglycemia.

Recommendations for physical activity	
Frequency	Daily
Intensity	Exercise should be performed to at least moderate intensity and should be gradually progressed to vigorous intensity as able where it is safe to maximize health benefits, particularly changes to HbA1c and aerobic capacity. A short period of warm up and cool down should be incorporated before and after the exercise sessions.
Type	Aerobic: – large muscle group activities e.g. walking, cycling, swimming Resistance: balance, proprioception and flexibility – e.g. yoga, Tai chi, referral to physiotherapy and through the gym.
Time	For those unaccustomed to exercise, starting at 15 minutes a day and building to 150 minutes a week is a recommendation.

If the recommended levels of physical activity cannot be achieved for various medical and personal reasons, doing some physical activity, even if it is less than the recommended guidelines, may provide some health benefits[193].

Cautions

- **Special considerations – all patients**
  - If blood sugar is ≤ 3.9 mmol/l, exercise should be postponed until carbohydrate has been taken and blood sugar ≥ 4 mmol/l. Exercise can be recommenced on the same day when blood sugar ≥ 4 mmol/l; however, care should be taken as risk of further hypoglycemia is increased. In the event of severe hypoglycaemia, exercise should be postponed.
  - Avoidance of hypoglycemia during exercise should not be achieved by significantly increasing pre-exercise blood glucose. Instead, treatment doses should be adjusted or extra carbohydrate should be taken at the start of exercise and during exercise if required.
  - Ensure adequate hydration: adequate fluids should be consumed before, during and after exercise.
  - Good foot care should be practiced by wearing proper shoes and cotton socks, and inspecting feet every time after exercise. Keep feet dry. Walking is safe in patients with uncomplicated peripheral neuropathy[194].
  - Medical identification should always be carried
  - During exercise, a source of rapid-acting carbohydrate (that ideally does not also contain fat) should be readily available. In general one hour of moderate exercise requires 15g of carbohydrate (vigorous activity may require 30g)[195]. Requirements may be higher in T1DM.

Criteria for referral:

1 For the majority of patients with diabetes, including those at high risk of CAD[192], recommending light to moderate activity such as brisk walking is safe and it is left to clinical judgment as to whether any clinical complications identified require further referral.

2 For those patients wanting to undertake vigorous activity, clinicians should use their clinical judgement to exclude any contraindications to exercise, in particular pertaining to cardiovascular disease.

3 All patients with no previous exercise stress test and with pre-existing CAD should be referred for exercise testing for a formal assessment of their response to exercise

Recommendations for physical activity (continued)

Cautions

- **Special considerations – Type I DM**
  - Check blood sugar before and after exercise (and every 60 minutes during if exercising for extended periods).
  - When starting exercise, aim for blood sugar between 7 – 10mmol/l.
  - Additional carbohydrate should be taken if required, especially in prolonged exercise, starting after 20 minutes.
  - If blood glucose pre-exercise is <7mmol/l then additional carbohydrate should be taken and exercise can start immediately.
  - If BM ≥ 14 mmol/l, check for beta-hydroxybutyrate (blood ketones) / urinary ketones. Exercise should be postponed if ketones are present and high blood sugar level should be treated.
  - If BM ≥ 14 mmol/l, AND beta-hydroxybutyrate < 0.6mmol/l * or urinary ketones absent, exercise can be undertaken provided adequate hydration and meticulous check of blood sugar levels as aerobic exercise is likely to cause blood sugar to decrease. If any doubt, postpone exercise.
  - Patients without methods to test blood / urinary ketones should discuss with their GPs on methods available for home testing to monitor for and prevent diabetic ketoacidosis. One should err in the side of caution and postpone exercise if any doubt arises.
- **Special considerations – Type II DM**
  - In the event of a hypoglycaemic event in individuals on insulin and oral hypoglycaemics, exercise should be delayed for 24 hours as the risk for hypoglycaemia is increased.
  - If blood glucose pre-exercise is <5.6mmol/l, extra carbohydrate should be taken and exercise can start immediately[196].
  - It may be helpful to check blood sugar before and after exercise (and every 60 minutes during if exercising for an extended period.
- Careful blood glucose monitoring, possible adjustments to treatment dosage and attention to diet around the time of exercise may be required to prevent hypoglycaemia during aerobic exercise (in those on insulin, or oral hypoglycaemic agents which affect insulin secretion).
- Exercise can enhance the absorption of insulin if injected into an exercising limb. This should therefore be avoided, with the abdomen or other alternative injection sites used.
- During prolonged exercise (>60 minutes), blood glucose should be checked every hour.
- There are no exercise restrictions for patients with nephropathy and albuminuria[198].
- In the presence of autonomic neuropathy, caution should be taken for hypotension or silent myocardial infarction
- In the presence of nephropathy, blood pressure should be monitored as high systolic BP (180-200mmHg) can aggravate development of kidney disease[199]. Only light to moderate exercise is advised in these patients.
- Patients with non-proliferative retinopathy can safely undertake light to moderate exercise. The risk in proliferative retinopathy is still low however vigorous activity involving impact and jarring is best avoided[200].

Recommendations for physical activity (continued)

Contraindications[201]

- The presence of active retinal hemorrhage.
- Treatment for retinopathy within 3 months e.g. laser treatment.
- Current illness or infection.
- Blood glucose > 14mmol/l and ketones are present (blood glucose should be lowered before initiation of exercise).
- Blood glucose < 3.9mmol/l (see above).
- Patients with peripheral neuropathy and a foot ulcer should not undergo weight bearing activity but can participate in non-weight bearing activity such as cycling or swimming.

Patients with autonomic neuropathy are not recommended to undertake vigorous activity and light to moderate activity should only be limited to sessions of shorter duration[202].

How does physical activity prevent diabetes?

- There is strong and consistent evidence that type II diabetes incidence and progression can be reduced with physical activity in those with impaired glucose tolerance (IGT) and that the effects are independent of weight loss[203].
- In a meta-analysis[204] regular physical activity halves the risk of developing diabetes (HR = 0.49). This compares favourably to diet only (HR = 0.67), but identical to combined diet and exercise (HR 0.49).
- In the same study numbers needed to treat (NNT) to prevent a case of diabetes in patients with are 6.4 for diet and exercise, 10.8 for anti-diabetic medication (e.g. Metformin) and 5.4 for Orlistat.
- 150 minutes a week of physical activity and diet induced weight loss of 5-7% reduces the risk of progression from Impaired glucose tolerance to type II DM by 58%[205,206].
- In one major study lifestyle intervention groups had a 43% lower diabetes incidence (age and clinic adjusted) for up to 14 years after the active intervention ceased, and diabetes onset was delayed an average of 3·6 years[207].

How can physical activity treat ciabetes?

- Physical activity improves blood glucose control in type II DM due to improved insulin sensitivity and this may enable reduction and even discontinuation of medication in a substantial proportion of patients[208,209,210,211].
- Either aerobic or resistance training improves glycemic control (measured with HbA1c) in type II DM, but the improvements are greatest with combined aerobic and resistance training[212].
- Exercise programmes can reduce glycated haemoglobin levels by approximately 0.6% as well as reducing adipose tissue and triglyceride levels[213].
- Cohort studies show that among patients with diabetes the least active and least fit have the highest mortality[214]. Church et al[215] found that men in the lowest, second, and third quartiles of cardiorespiratory fitness had 4.5, 2.8 and 1.6-fold greater risk for overall mortality than men in the highest quartile of cardiorespiratory fitness. *"Essentially all of the association between higher BMI and higher mortality was explained by confounding with cardiorespiratory fitness; there was no difference in mortality among normal-weight, overweight, and obese men after adjustment for cardiorespiratory fitness".*

Mechanisms – see Chapter 20

18

DEPRESSION AND PHYSICAL ACTIVITY

Summary

- NICE recommends physical activity as an effective treatment for depression.
- There is strong evidence that regular physical activity reduces the risk of depression possibly by as much as a third.
- 150 minutes of moderate activity and/or 75 minutes of vigorous activity is recommended with possible greater benefit from being outdoors in green space

.

Recommendations for physical activity	
Frequency	Daily
Intensity	As per DH guidelines of 150 minutes of moderate activity and/or 75 minutes of vigorous activity.
Type	The addition of walking with other people and in green space has been shown to have a positive effect on mental health. NICE Recommends Health Walks specifically as an effective way to improve wellbeing in the elderly. For active people, sport activities may provide distraction through their sociable nature.
Time	For those unaccustomed to exercise, starting at 15 minutes a day and building to 150 minutes a week is a recommendation.
Cautions and contraindications	
Underweight patients with diagnosed eating disorders should not be prescribed exercise for depression[216]	

Can physical activity prevent depression?

Physical activity is inversely related to depression[217,218,219,220]. In a German population group, Weyerer found that those who reported no physical activity ran three times the risk of developing moderate to severe depression as those who reported being physically active[221]. A well-known study is that of Paffenbarger[222] and colleagues from 1994 in which they followed Harvard students of physical activity and exercise to depressive illness. The conclusion was that those who engaged in regular physical exercise had a lower risk of developing depression. The effect was clearly dose-dependent. However there is one study published by Cooper-Patrick and colleagues[223] with a 15-year follow-up that showed no relationship between inactivity and depression.

In a 2007 report from the Caerphilly Study in Wales that there is a relation between a high level of physical activity in leisure time and at work, and reduced incidence of mental disorders (mainly depression and anxiety), at a 5-year follow-up but not after 10 years[224]. A more objective study from Japan measured the physical activity of 184 individuals, aged 65–85 years, with an accelerometer and pedometer, for one year. They found a significant negative relationship between physical activity and depressive symptoms[225].

However although there is strong evidence that inactivity is related to depression it is not so clear whether it is physical inactivity that leads to depressive symptoms or whether it is depression that leads to inactivity.

Can physical activity treat depression?

NICE Guidelines[226] recommend the following:

For people with persistent subthreshold depressive symptoms or mild to moderate depression and a chronic physical health problem, and for people with subthreshold depressive symptoms that complicate the care of the chronic physical health problem, consider offering structured group physical activity programme (along with CBT and group based peer support) , guided by the person's preference. The activity programme should:

- be modified for different abilities according to the physical programme health problem, in liaison with the team treating the physical health problem
- be delivered in groups supported by a competent practitioner
- typically consist of 2–3 sessions per week (lasting 45 minutes to 1 hour) over 10–14 weeks
- be coordinated with any rehabilitation programme for the physical health problem.

A meta-analysis[227], and a Cochrane collaboration[228] showed that regular physical activity has similar efficacy to cognitive behavioural therapy in treating depression. The Cochrane review for the 23 trials (907 participants) comparing exercise with no treatment or a control intervention, the pooled SMD was -0.82 (95% CI -1.12, -0.51), indicating a large clinical effect. However, when they included only the three trials with adequate allocation concealment and intention to treat analysis and blinded outcome assessment, the pooled SMD was -0.42 (95% CI -0.88, 0.03).

A study in which 156 patients aged 50–77 years were randomly divided into three treatment groups. The trial lasted for four months. Group 1 was treated with sertraline 50–200 mg per day. The second group received exercise training in the form of 30 minutes of walking and jogging, 3 times a week. The third group received both sertraline and exercise training. They found no significant difference in treatment effect between the three groups, and all showed a good effect from the treatment[229]. The recent TREAD study[230] confirmed these findings by demonstrating that the addition of physical activity to usual care of depression in primary care showed no significant benefit. It appears that there is benefit to using physical activity as a sole treatment for mild to moderate depression but no evidence to show benefit when it is added to usual care.

Possible mechanisms: see Chapter 20.

19

OSTEOPOROSIS AND PHYSICAL ACTIVITY

Summary

- Physical activity improves muscle strength, mobility and balance, all of which help reduce the risk of falls and thereby reduced the risk of fractures[231,232], and improves quality of life.
- Lack of physical exercise is associated with low BMD and increased risk of osteoporosis in later life[233].
- Complete bed rest results in calcium loss of 200-300mg per week. BMD in trabecular bone is lost at the rate of 1-2 % per week, while BMD in cortical bone is lost at the rate of 1% per month.
- Women can lose up to 20% of their bone mass in the five to seven years after menopause. Together with lower peak bone mass in young adulthood, this can result in higher incidence of osteoporotic fractures in women as compared to men[234].

Minimal work-up before recommending physical activity

History and examination:

Presence of tendency of falls, pain assessment, lumbar mobility, assessment of kyphosis as this may limit the type of activity performed. Investigation: Dexa Scan to understand degree of osteopaenia or osteoporosis before recommending physical activity, (serum calcium, phosphate, Alkaline phosphatase, vitamin D and parathyroid hormone) to investigate secondary hyperparathyroidism or osteomalacia.

Recommendations for physical activity	
Frequency	Daily
Intensity	Mild to moderate intensity activities.
Type	Walking and other mild to moderate activities. Tai Chi and Pilates should be incorporated to improve balance and coordination. Lumbar extension exercises appear to be safe[235].
Time	For inactive starting with 15 minutes daily and building up to 150 minutes/week – see Chapter 4 UK Guidelines.

Cautions and contraindications

Ensure that the exercise environment is free of hazards that would increase risk of falling e.g. loose floor tile, mats or exercise equipment. Wall or side-railing may help.

Trunk flexion exercises should not be prescribed to patients with osteoporosis who are at high risk of fracture[236]. This includes those taking systemic corticosteroids for a cumulative period of 3 months or greater during the preceding year at a prednisolone-equivalent dose ≥ 7.5mg daily.

Patients recovering from hip fracture should not perform physical activity for more than 15-30 minutes per session, early in the rehabilitation process as it can increase orthopaedic complications. Weight bearing exercise can be started after 18 days, and resistance exercise can be progressively incorporated 1 month following in-patient rehabilitation (Level 2, Grade A)[237]. Powerful twisting movement of the trunk should be avoided (Level 3, Grade C).

How does physical activity prevent osteoporosis?

A gradual loss of bone density takes place from around the age of 20, when the maximum bone mass is fully developed until menopause[238]. Studies have shown that weight bearing activities maintain existing bone mass[239,240].

How does physical activity benefit osteoporosis?

Regular aerobic, weight-bearing and resistance exercise training has been shown to have a positive effect on the bone mineral density (BMD) of the spine in post-menopausal women. Walking is effective for hip BMD.

Balance, strength training and lumbar[241] stabilization exercises lead to an improved daily functional capacity and quality of life with better balance and less pain.

C

MECHANISMS AND APPENDICES

20

THE MECHANISMS OF PHYSICAL ACTIVITY: HOW DOES IT WORK?

Anti-inflammatory

This is perhaps the most important benefit of physical activity.

Chronic low-grade inflammation is a key player in the pathogenesis of most long term conditions. TNF alpha is released during the inflammatory response and is a key component to chronic inflammation. It is an important cytokine and this has a direct effect on insulin resistance and detrimental effects on the endothelium

In many ways a bout of muscle contraction in exercise is similar to a stimulus such as an infection except that is not TNF alpha that is released but, instead large amounts of a cytokine called Inter-Leukin 6 (IL6) from the contracting muscle. IL6 has both an anti-inflammatory and an inflammatory role yet when released by muscle improves insulin sensitivity, oxidises fat and acts as an anti-inflammatory. Levels can increase 200-fold during exercise and it continues to be produced from muscle for at least 24 hours after a bout of exercise so that levels remain high in those that take regular activity.

> The muscle is now thought to be an important endocrine organ releasing IL6 when it contracts leading to a powerful anti-inflammatory response, insulin sensitivity and fat oxidation.

Cardiovascular effects

A large study[242] of 27,000 women demonstrated that the most active women (>1500kcal/wk compared to <200kcal/wk) had a 41% reduction in CVD events after 10 years. The risk factors that are modified by physical activity account for 59% of this reduction (see Table 8), with inflammation and reduced blood pressure making the largest contribution.

Table 8: Risk factors modified by physical activity and the percentage contribution they each make to reducing CVD events: i.e. the mechanisms behind how physical activity benefits CVD mortality

Inflammatory hemostatic (hCRP Fibrinogen etc)	33%
Blood pressure	27%
Traditional Lipids (total Cholesterol, LDL, HDL,)	19%
Novel Lipids (Lipoprotein, Apolipoprotein)	15%
BMI	10%
HbA1c and Diabetes	9%
Homocysteine	1%
All risk factors above	59%

Endothelial function

The endothelium, the cell layer lining the blood vessels, plays a key role in a number of vascular functions. Impairment of arterial endothelial function is an important early step in the atherosclerotic process and a predictor of cardiovascular disease[243]. Brachial artery flow-mediated dilation (FMD) is widely used as a marker of systemic arterial endothelial function. FMD is associated with coronary atherosclerosis[244] and predicts the likelihood of cardiovascular events[245].

In men and women with metabolic syndrome, 12 weeks of aerobic interval training, resistance exercise training or combined training, increased brachial artery FMD by 28% to 38% in all groups, despite no change in body weight[246].

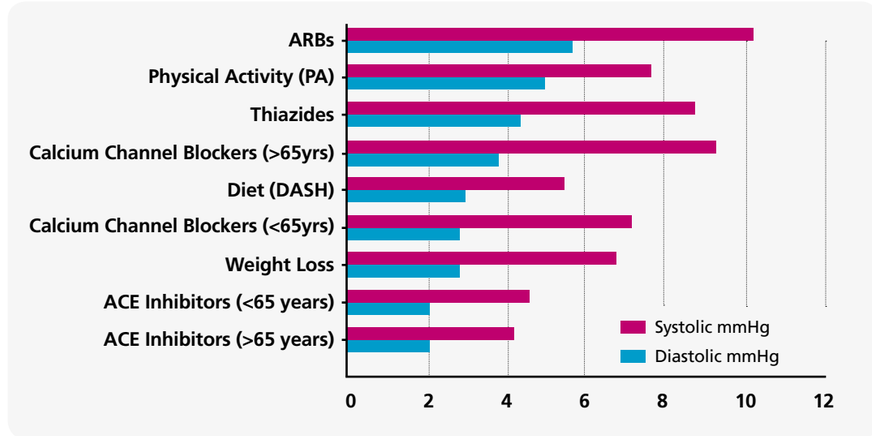
In one study, a one year period of resistance exercise training in overweight women was reported to increase brachial artery FMD by 41%, without a reduction in total body fat mass[247].

Hypertension

Both aerobic and resistance exercise training reduce blood pressure through reducing pulse rate and improving endothelial function. These benefits are independent of weight loss although weight loss in obese patients is still an important part of blood pressure control[248].

In a 6-week program in which 168 overweight men and women with stage I hypertension participated in brisk walking, 24-hour ambulatory systolic and diastolic blood pressures were reduced (systolic, from 143.1 to 135.5 mm Hg; diastolic, from 91.1 to 84.8 mm Hg) without reducing body weight[249]. A meta-analysis of 72 exercise intervention trials found that training reduced resting and ambulatory blood pressure in in individuals with hypertension by approximately 7/5 mm Hg[250]. In a meta-analysis[251] it was demonstrated that resistance training in both normotensive and hypertensive individuals resulted in a 3% to 4% reduction in blood pressure with no significant changes in body weight.

Figure 6: A comparison of different anti-hypertensive treatments comparing medication with physical activity and weight loss in reducing blood pressure in hypertension[252,12,253,254] (mmHg reduction)



Haemostasis

Physical activity improves the coagulability by decreasing levels of fibrinogen and other clotting factors[255]. In a large study of 4000 elderly men, physical activity showed a significant and inverse dose-response relationship with fibrinogen, plasma and blood viscosity, platelet count, coagulation factors VIII and IX, von Willebrand factor, fibrin D-dimer, tissue plasminogen activator antigen, C-reactive protein and white cell count, even after adjustment for possible confounders[256].

In a 16-week, home-based aerobic exercise intervention[257] of ≥ 150 minutes per week in 25 sedentary, overweight subjects with Type2 diabetes, the MMP-9/TIMP-1 ratio (which is an independent predictor of CHD) was improved by 33%. There was also a 17% decrease in fibrinogen and a 30% decrease in C-reactive protein (CRP), despite no change in BMI.

Lipids

Physical activity has favorable effects on lipids and lipoproteins, even with unchanged body weight[258]. A meta-analysis of 27 studies concluded that aerobic exercise was associated with a small but statistically significant effect on increasing high-density lipoprotein cholesterol (HDL-C) levels and exhibited a trend toward decreasing serum triglyceride levels[259].

Aerobic exercise may be of particular value in treating individuals with the most atherogenic lipid profiles. In one study, 20 weeks of aerobic exercise training was more effective at improving lipid and lipoprotein profiles in overweight men with a combination of low HDL-C and elevated triglycerides than in men with either isolated low HDL-C or elevated triglycerides[260]. High-density lipoprotein cholesterol was increased by 4.9% and triglycerides were reduced by 15%, despite small changes in weight (–0.7 kg) and fat mass (–1.1 kg).

Insulin resistance

Insulin resistance increases the risk of both diabetes and cancer of the breast, colon, pancreas and endometrium. Insulin can enhance tumour development by stimulating cell proliferation or inhibiting apoptosis[261].

Both physical activity and obesity independently cause insulin resistance. There is little evidence that the aging process alone increases insulin resistance[262]. Instead it is more likely that older age is related to increasing inactivity and weight gain. Physical activity on its own can significantly:

- Increase glucose tolerance
- Reduce fasting glucose
- Enhance insulin sensitivity
- Reduce HbA_{1C}

Acute bouts of physical activity improve insulin sensitivity and increase glucose uptake by skeletal muscle, even in those with Type2 diabetes mellitus, for up to 12 hours[263].

Chronic exercise training results in prolonged improvements in insulin sensitivity[264,265,266]. Resistance exercise may be more effective as the mechanism of insulin sensitivity is based in the muscles.

Musculoskeletal

Muscle

Aerobic exercise training results in an increase in mitochondrial function and an increase in capillarization both of which are highly related to improving insulin sensitivity and fat disposal. It may only take 12 weeks of combined resistance and aerobic exercise in obese patients to restore mitochondrial function to the level of a healthy control subject despite no change in weight.

Physical activity releases free radicals (Reactive Oxidative Species, ROS) and so one would expect more DNA damage within the cell. However a constant production of ROS helps to stimulate the manufacture of an ample supply of anti-oxidants that not only helps to mop up the ROS but also helps to maintain the health of the cell. This may be a critical way in which physical activity improves health.

Osteoarthritis

Contrary to the popular myth that exercise causes more 'wear and tear' of joints in fact regular moderate physical activity protects and strengthens joints and as a result reduces pain and increases function.

There appear to be three mechanisms by which physical activity helps to prevent osteoarthritis.

- Increased muscle strength and proprioception
- Improved quality of cartilage
- Weight loss

Muscle strength

- Muscles are important in maintaining a healthy joint. They produce movement, absorb loading, and provide dynamic joint stability[268,269,270].
- Muscle weakness is thought to be one of the main risk factors of osteoarthritis along with poor limb alignment and obesity[272,272,273,274].
- Weaker muscles occur as a result of inactivity, aging, after injury or with joint pain such as OA. Weak muscles not only tire more rapidly, but they also display a slower voluntary and reflex motor control.
- Once the protective muscular control is lost, excessive joint movement and instability with pathological shear and peak joint forces occur. This leads to:

1. Stress-induced micro-trauma to the articular cartilage.
2. Consequent cartilage degeneration.
3. Pathological sub-chondral pressure increase.
4. Consequent sub-chondral bone sclerosis.
5. Joint collapse with axis deviation.

Quality of cartilage

- Studies using MRI scans have shown that after just 10 weeks of moderate physical activity the glycosaminoglycan levels are increased in knee cartilage[275,276]. This suggests chondro-protective effects which will be valuable in OA prevention.
- In a systematic review[277] of the knee, physical activity was associated with reduced cartilage defects, greater cartilage volume but increased osteophytes. However it was discussed that osteophytes increase stability and distribute the load and so when associated with healthier cartilage may actually create a healthier joint.

Weight loss

There is strong evidence that obesity is related to osteoarthritis of the knee and hand and moderate evidence linking it to OA of the hip✦.

Back pain

Despite considerable academic attention low back pain remains difficult to fully explain particularly as emotional and psychosocial factors play a major role. This creates large differences both within and between individuals.

Peripheral nerve endings (nociceptors) are in each part of the spine except the central disc[278]. However recent research has found that these nociceptors migrate into the centre of degenerative discs through scar tissue[279,280]. When stimulated they cause pain that may directly contract back muscles[281,282]. These muscles may then continue to contract long after the initial stimulus has healed (usually 2-3 days)[283]. All tissue around the spine has nociceptors that may contribute to this pain.

Even after a few days of pain and rest, muscles around the lumbar spine start to atrophy. This may be exacerbated by negative reflexes from nociceptors that inhibit movement in some muscles[284,285,286].

There is associated lower bone mineral content in patients with chronic low back pain resulting in not only weaker vertebrae but also weaker tendons, ligaments and other soft tissue[287].

✦ Grotle M, Hagen KB, Natvig B A Dahl FA and Kvien TK. Obesity and osteoarthritis in knee, hip and/or hand: An epidemiological study in the general population with 10 years follow-up. *BMC Musculoskeletal Disorders* 2008, 9:132 doi:10.1186/1471-2474-9-132

The direct effects of aerobic training on back pain have not been completely established but the following are current theories. General physical activity:

- Increases endorphin production.
- Generates movement of the spine when walking or jogging which transports pain inducing metabolites in and out of the relatively avascular disc[288].
- Has an 'activating' effect on painful and contracted back muscles.
- Breaks down the fear of movement, increases self-confidence and reduces social isolation and exclusion that can all contribute to better pain control[289,290].

Immune system

Physical activity can improve the number or function of natural killer cells, which have a role in tumour suppression and reduction of infections[291]. Bouts of exercise have been shown to result in acute increases in of components of immune function (for example, neutrophils, monocytes, eosinophils and lymphocytes), followed by a dip below pre-exercise levels lasting up to 1–3 hours [292]. There is an inverted J-shaped dose-response relationship between chronic physical activity and enhanced immune function whereas exhaustive exercise, overtraining or high-intensity exercise may lead to immunosuppression, which can give rise to e.g. increased susceptibility to upper respiratory tract infections.

Physical activity and cancer: Mechanisms

Physical activity can prevent cancer in several ways:

Hormonal

Physical activity reduces both circulating oestrogen and progesterone levels affecting endometrial, ovarian, prostate and breast cancer.

Physical activity increases insulin sensitivity that is linked to many cancers. Insulin stimulates cell proliferation. Diabetes mellitus is associated with a significant (16%) increase in postmenopausal breast cancer risk

Reducing inflammation

Physical activity reduces chronic inflammation which is associated with a higher risk of cancer. Inactivity is associated with less intracellular antioxidant production leading to increased vulnerability of cells to reactive oxidants.

Immunity

Physical activity stimulates the production of Natural Killer Cells that scavenge for cancer cells.

Physical activity and diabetes: Mechanisms

Type II diabetics have 3-4 times higher risk of developing myocardial infarction and stroke, physical activity lowers risk factors for CHD[293,294,iii]. These include decreased systemic inflammation, improved early diastolic filling (reduced diastolic dysfunction), improved endothelial vasodilator function, and decreased abdominal visceral fat accumulation. There is a modest effect on lipid profile[295] and blood pressure[296].

Physical activity increases insulin sensitivity through several mechanisms increase. These include increasing aspects of insulin signaling cascade which up-regulates insulin-stimulated glucose uptake and transport and increase in GLUT 4 protein concentration[297,298].

Physical activity increases numbers and size of mitochondria and switches on enzymes that manufacture anti-oxidants. Paradoxically inactivity and obesity create more reactive oxidative species (ROS or free radicals) due to unused spare electrons reacting with oxygen and damaging mitochondria. Insulin resistance is strongly linked to ROS and damaged mitochondria[299].

Physical activity and depression: Mechanisms

There is still no clear understanding as to how physical activity benefits patients with depression however Kjellman et al in the 'Swedish Manual of Physical Activity'[300] goes through the current thinking.

Behaviour change

Physical activity involves a change in behaviour, a behaviour modification. In depression, a person's behaviour is often characterised by passiveness, withdrawal and isolation. Changing behaviour can affect thoughts and emotions, and in doing so contribute to reversing depression[301]. Physical exercise has been shown to encourage positive thoughts and emotions, increased confidence in coping, and increased self-confidence and capacity for self-control.

Resilience

Another possible psychological mechanism is that one becomes more resistant to stress through physical exercise. This could be linked to reduced activity in the hypothalamus-pituitary-adrenocortical axis, whose function is often pathologically increased in depression[302]. Increasingly important research shows that psychological distress is significantly improved through just 20 minutes of physical activity a week[303].

Neurotransmitters

Physical activity improves synthesis and metabolism of the neurotransmitters noradrenaline, serotonin and dopamine in test animals[304]. Definite proof that this is the case in humans is not available yet, however, though it is a plausible hypothesis of an important underlying mechanism.

Endorphins

A popular hypothesis is that the effect of exercise is due to an increased concentration of endorphins, that is, the body's own morphine. Both rat and human trials support this hypothesis[305,306], but more research is needed on the effect of endorphins in the brain of patients being treated with physical exercise.

Cell regeneration

Exercise may help in cell regeneration in some parts of the brain, especially the hippocampus, which is used for learning and memory. Researchers have found a lower hippocampal volume in depressed individuals[307] and that treatment with antidepressant drugs yields regeneration of cells there[308]. A research group at Karolinska Institute in Sweden have recently found in animal studies that physical activity regenerates parts of the brain that are depleted in depression.

Physical activity and osteoporosis: Mechanisms

Bone tissue that is subject to dynamic load responds with a cellular reaction characterized by an acute release of prostaglandins which leads to production of growth factors and subsequent bone renewal in response to the original load[309].

Rapid bone resorption takes place in the absence of weight-bearing load as seen during space missions and immobilizations[310,311].

Reduced muscle strength, balance and coordination are risk factors for falls. Physical activity can help reduce these risk factors and consequently, reduce and prevent the risk of fracture.

can increase 200-fold during exercise and it continues to be produced from muscle for at least 24 hours after a bout of exercise so that levels remain high in those that take regular activity.

A1

Selected activities and their MET value and Energy Expenditure

Activity	Intensity for an average 50 year old male	Intensity (METS)	Energy expenditure (Kcal equivalent, for a person of 60kg doing the activity for 30 minutes)
Painting/decorating	Moderate	3.0	90
Hoovering	Moderate	3.5	105
Food shopping	Light	2.3	69
Gardening	Moderate	4.0	100
Mowing lawn – power mower	Vigorous	5.5	165
Ballroom dancing (fast)	Moderate	4.5	135
Aerobic dancing	Vigorous	6.5	195
Golf – Walking, Pulling Clubs	Moderate	4.3	129
Badminton – social	Moderate	4.5	135
Tennis – doubles	Moderate	5.0	150
Tennis – singles	Vigorous	8.0	240
Walking			
2.0 mph	Light	2.5	75
3.0 mph	Moderate	3.3	100
4.0 mph	Moderate	5.0	150
4.5 mph	Vigorous	6.3	189
Running			
6.0 mph	Vigorous	10.0	250
7.0 mph	Vigorous	11.5	345
8.0 mph	Vigorous	13.5	405
Cycling			
10-12 mph	Moderate	6.0	180
12-14 mph	Vigorous	8.0	240
14-16 mph	Vigorous	10.0	250
The most energetic sports			
Running (5.5 mins / mile)	Vigorous	18	540
Cross Country Skiing	Vigorous	16.5	495
Speed Skating	Vigorous	15	450
Boxing	Vigorous	12	360
Rowing	Vigorous	12	360
Butterfly Swimming	Vigorous	11.0	330
Football	Vigorous	10	250

A2

Active People Survey (2011) showing the percentage of the adult population in each borough who achieve less than 30 minutes of activity a week, 1x30 minute sessions and 5x30 minute sessions a week.

	% of adults doing less than 30mins of PA a week	Difference from the national average of 29.5%	% of adults doing at least 30 min of PA once a week	Difference from the national average of 58.9%	% of adults doing at least 30 mins of PA five times a week	Difference from the national average of 21.5%
Camden	25.0%	-4.5%	62.4%	3.5%	24.8%	3.4%
Islington	28.2%	-1.3%	60.9%	2.0%	23.7%	2.3%
Kensington and Chelsea	27.5%	-2.0%	65.3%	6.4%	25.1%	3.6%
Lambeth	29.1%	-0.4%	56.4%	-2.5%	25.1%	3.6%
Southwark	31.5%	2.0%	55.7%	-3.2%	22.1%	0.7%
Wandsworth	23.3%	-6.2%	66.7%	7.8%	27.1%	5.7%
Westminster	28.9%	-0.6%	61.3%	2.3%	26.7%	5.2%
Barking and Dagenham	40.2%	10.7%	46.7%	-12.2%	18.8%	-0.2%
Bexley	30.1%	0.6%	57.8%	-1.1%	18.9%	-0.3%
City of London	35.5%	6.0%	62.2%	3.3%	19.9%	-1.5%
Greenwich	32.4%	2.9%	51.2%	-7.7%	17.9%	-3.5%
Hackney	27.4%	-2.1%	62.6%	3.7%	25.3%	3.8%
Havering	36.9%	7.4%	46.4%	-12.5%	15.2%	-6.2%
Lewisham	28.8%	-0.7%	59.9%	1.0%	20.6%	-0.9%
Newham	41.0%	11.5%	47.9%	-11.0%	16.2%	-5.3%
Redbridge	38.5%	9.0%	51.5%	-7.4%	18.0%	-3.5%
Tower Hamlets	35.3%	5.8%	54.2%	-4.7%	16.9%	-4.5%
Barnet	32.4%	2.9%	57.1%	-1.8%	18.9%	-2.5%
Enfield	34.5%	5.0%	52.8%	-6.1%	19.2%	-2.3%
Haringey	28.2%	-0.7%	57.1%	-1.8%	19.0%	-2.4%
Waltham Forest	31.8%	5.0%	56.2%	-2.7%	20.4%	1.1%
Bromley	23.8%	-0.7%	66.3%	7.4%	20.5%	-1.0%
Croydon	27.0%	-0.7%	59.8%	0.9%	20.1%	-1.4%
Kingston upon Thames	21.8%	-0.7%	64.2%	5.3%	22.2%	0.7%
Merton	29.1%	-0.7%	58.8%	-0.1%	22.6%	1.2%
Richmond upon Thames	22.8%	-0.7%	68.4%	9.4%	27.1%	5.7%
Sutton	20.6%	-0.7%	65.2%	6.3%	18.2%	-3.2%
Brent	36.5%	5.0%	53.1%	-5.8%	19.7%	-1.8%
Ealing	34.3%	5.0%	50.9%	-8.0%	16.8%	-4.6%
Hammersmith and Fulham	25.6%	-0.7%	65.0%	6.1%	28.6%	7.2%
Harrow	35.8%	5.0%	50.6%	-8.3%	16.1%	-5.4%
Hillingdon	35.4%	5.0%	52.0%	-6.9%	18.5%	-2.9%
Hounslow	38.2%	5.0%	50.7%	-8.3%	16.8%	-4.7%

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A separate project report covering the pilot of 'My Best Move' in London is also available.

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