Lifestyle discussions: Physical activity and type 2 diabetes

Physical activity (PA) is any movement produced by skeletal muscles that requires energy expenditure.[1] The energy expended is predominantly determined by the intensity, duration and frequency of muscular movement. Moderate-intensity PA is defined as ≥3 metabolic equivalents (METs) and vigorous-intensity as ≥6 METs (i.e. burning at least 3 and 6 times as much energy as at rest, respectively). Examples include walking for exercise (4.3 METs) and jogging (7 METs).[2] Regular PA can facilitate the prevention and management of over 35 chronic conditions and diseases,[3] including type 2 diabetes. Persuading inactive people to become more active could prevent one in ten cases of stroke and heart disease in the UK, and one in six deaths from any cause.[4] Even small, regular changes can make a difference to long-term health. The more you do, the greater the benefits. Just 5 minutes of extra walking every day has been shown to improve health.

Adults, including those with type 2 diabetes, are encouraged to undertake a minimum of 150 min/week of moderate-intensity PA spread over ≥3 days/week. Vigorous-intensity activity can be substituted for moderate-intensity in those already physically active, with a minimum of 75 min/week suggested. This should be supplemented with 2–3 resistance, flexibility and/or balance training sessions/week.[5,6] Sedentary behaviours should also be limited, with prolonged periods of sitting interrupted at least every 30 min.[5]

The evidence underpinning these guidelines is largely derived from self-reported measures, which introduce recall and response bias, and the inability to accurately capture absolute levels of PA. Recent investigations have incorporated wearable devices to provide a more robust quantification of the dose–response relationship between PA and health.[7–9] Results suggest the benefits of PA may actually be greater, and occur at a lower level, than previously perceived.[10,11]

Evidence base to inform PA prescriptions

- Although individuals are encouraged to work towards the PA guidelines,[6] benefits can be achieved at levels below (and above) these thresholds. Any PA is better that none, but more is better, especially when combined with a reduction in sitting time.[8,12]
- All intensities of PA are associated with a substantially reduced risk of mortality in a dose–response manner (up to a plateau of ~150 min/week of moderate-to-vigorous intensity and ~300 min/week for light-intensity PA, such as "pottering around").[8]
- An increase of as few as 500 steps/day is associated with a 2%–9% decreased risk of cardiovascular morbidity and all-cause mortality, including in those with type 2 diabetes or prediabetes.[13–17]
- One 5–6-min brisk-intensity walk/day (~500 steps in 5 min) equates to ~4-year greater life expectancy.[16,18–20] This activity can be accumulated throughout the week, such as 10 min of walking, three times/week. The American Diabetes Association recommends avoiding more than 2 consecutive days without any PA for optimal benefit.[5]
- Higher volumes of activity energy expenditure are associated with lower mortality rates, and achieving the same energy expenditure through higher-intensity activity is associated with greater benefits than through lower-intensity activity.[9]
- Breaking up prolonged sitting time (every 30 min) with short regular bouts of slow walking and simple resistance exercises (e.g. calf raises and squats) can improve glucose metabolism.[21–23] Small "doses" of PA may improve post-prandial glucose and insulin levels more than moderate-intensity continuous exercise,[24–26] with greater effects in people with insulin resistance and a higher BMI.[27]
- Importantly, all of these estimates are specific to an inactive population, meaning the gains are especially significant for those currently doing <30 min/week of purposeful activity. That said, a higher intensity and duration of activity will elicit a greater range and magnitude of physiological adaptations.[6]
- Aerobic (any activity that uses large muscle groups and is rhythmic in nature), resistance (any activity that involves using your body weight or working against a force) or a combination of the two (totalling >150 min/week) reduces HbA_{1c} by ~0.8% (~8 mmol/mol), compared to inactive individuals.[28]
- Individual preferences, motivations and circumstances should inform choice. For example, a focus predominantly on resistance activity may be more important in those with frailty or poor physical function, given their higher risk of falling.

Importance of PA in those with type 2 diabetes

- Regular PA is associated with a myriad of physiological and psychological benefits across the life course in those with type 2 diabetes.
- The short-term effects of PA (typically lasting <72 hours) are driven by the exercise duration, intensity and subsequent food intake.[29,30]
- Longer-term effects also involve "organ crosstalk", such as from skeletal muscle to adipose tissue, the liver and the pancreas, all of which mediate favourable effects on HbA_{1c}, blood glucose levels, blood pressure and lipid profiles.[5]

How does PA impact common comorbidities in type 2 diabetes?

- PA represents a challenge to whole-body homeostasis, and provokes widespread changes in numerous cells, tissues and organs in response to the increased metabolic demand.[31,32]
- Muscle mass maintenance is central to healthy human physiology, providing the dynamic biomechanical device needed for locomotion, physical function and the completion of essential daily activities.[33] It also plays a fundamental role in maintaining cellular homeostasis and reducing the risk of frailty.[34–36]
- Regular PA can also be an efficient tool to promote mental health, protecting against cognitive impairment and/or degenerative diseases,[37] whilst eliciting moderate improvements in diabetes-related depression.[38]
- PA improves cardiovascular function through adaptations to the heart (e.g. resting heart rate) and vascular system (e.g. blood pressure).[30,39]

Recommending PA in clinical practice

- Type 2 diabetes is characterised by low levels of PA and poor physical function. Fewer than 5000 steps/day is common. For inactive individuals, increasing activity by 500 steps/day or 5 min of walking/day is a great first step.
- When initiating conversation around PA promotion, consider an **ABC approach**: **Assess**/ask about current PA; use a **Brief** intervention to set goals or prescriptions; and provide **Continuing** support.
- When asking about current PA, ask about frequency ("How many days/week do you undertake moderate-intensity PA, such as brisk walking?") and duration ("How long on average is each activity session?").
- Ask about habitual walking pace: "How would you describe your usual walking pace: slow (<3 mph), average (3–4 mph) or brisk (>4 mph)?" Those who answer "slow" have worse outcomes than those with obesity.[40,41]
- Use the talk test to help support conversation around exercise intensity:
  - If you can sing, intensity is **light**.
  - If you can talk, but not sing, intensity is **moderate**.
  - If you cannot sing or talk, intensity is **vigorous**.
- Brief advice from healthcare professionals is effective and an important part of helping people with long-terms conditions become more active.[42]
- Specific exercise prescriptions can promote behaviour change, including the Diabetes UK PA information and prescription sheet.
- PA trackers, that count steps, are effective in supporting PA behaviour change through enabling goal setting and feedback,[43] including in type 2 diabetes.[44] Smart phones can be used to count steps and provide support through NHS-endorsed apps (see below).
- Many local authorities run exercise-on-referral schemes for those with long-term conditions, accessed through primary care. There are community-led PA schemes that are run locally and nationally, including parkrun, which collaborates with the RCGP to use events to promote PA.

Summary of practical implementation

Very brief advice (1–2 min)

- Summarise the key benefits of PA for diabetes.
- Motivate individuals to do more than their current PA levels.
- Address any safety concerns, if necessary.
- Signpost to appropriate further information, tools and local schemes.

Brief advice (up to 5 min) – as above, plus:

- Discuss and motivate individuals to think of ways to add more PA into their daily routine; provide examples.
- Provide a written prescription; review at subsequent appointments.

More time – as above, plus:

- A person-centred approach, discussing all relevant information about integrating PA into their lifestyle.
- Harness PA tracking apps and devices to enable people to set goals and monitor progress.

Safety aspects of recommending PA

- In the vast majority of those with stable long-term conditions, including diabetes, the benefits of an active lifestyle far outweigh any risk.[45]
- A gradual increase in overall volume and intensity of walking activity, in accordance with PA recommendations, should not be hazardous in terms of triggering a cardiac event and does not require medical clearance.[45]
- Clinical assessment beyond ongoing type 2 diabetes management may be warranted for individuals experiencing adverse symptoms at lower intensities, in those prescribed insulin or those with a history of hypoglycaemia. Insulin regimen and carbohydrate intake changes should be used to prevent activity-related hypoglycaemia (e.g. reductions in basal insulin doses, inclusion of bedtime snacks and/or use of continuous glucose monitoring).[5]

Additional diabetes-related complications requiring clinical assessment:

- *Diabetic retinopathy*. For moderate-to-severe retinopathy, activities that dramatically increase blood pressure, or activities involving jumping, jarring, head-down or breath-holding, should be avoided.[5]
- *End-stage diabetic kidney disease or dialysis*. Limit exercise to low intensity.[5]
- *Peripheral neuropathy*. People with active ulcers, amputations or foot deformity should avoid any weight-bearing exercises and opt for arm exercises, swimming or cycling (if possible).

Other temporary contraindications include acute systemic infections, severe exacerbations of inflammatory joint disease or musculoskeletal injury, severe hypertension or unstable heart failure.[5]

Mechanisms

Regular PA stimulates a number of physiological changes that facilitate increased glucose delivery, uptake and metabolism in skeletal muscle:

1. *Delivery*. Blood flow to skeletal muscles increases up to 20-fold compared to resting conditions.[46]
2. *Uptake*. Skeletal muscle contractions increase presence of glucose transporter type 4 (GLUT4) proteins on the surface of muscle cells. Glucose diffuses into muscle cells primarily through these proteins, so this, coupled with the increased glucose delivery, leads to an increased rate of glucose diffusion into the contracting muscle.[29]
3. *Metabolism*. Once glucose enters the muscle cell, it is incorporated into a chain of reactions that eventually lead to the generation of energy (glycolysis). The intensity, duration and type of activity determine the mechanisms through which this extra energy is supplied.[29]

Although these processes are independent of insulin, there is a high degree of overlap with mechanisms responsible for insulin-stimulated glucose uptake into muscle cells.[35] Stimulation of both can lead to an excessive response, increasing the risk of hypoglycaemia, particularly in those prescribed insulin or insulin secretagogues (see **Safety aspects of recommending PA**).

Online PA resources

- Physical activity guidelines: UK Chief Medical Officers' Report
- Physical activity: for NHS staff, patients and carers
- Moving Medicine
- Motivate 2 Move
- RCGP: Physical activity and lifestyle toolkit
- How to recommend physical activity to people with diabetes safely
- NHS Live Well
- Better Health: Get active

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