Physical activity: Targeting movement over obesity in type 2 diabetes

Charlotte Jelleyman, Tom Yates

The importance of engaging in regular physical activity is well known and guidelines for frequency, intensity and duration of participation have been determined by the World Health Organization. These guidelines are reproduced and reinforced by national government bodies such as NICE and the Departments of Health and Education. All recommend that adults take part in at least 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity activity per week; however, it is thought that as few as 5% of people achieve this minimum recommendation. The decline of habitual physical activity has coincided with an increased prevalence of metabolic dysfunction and type 2 diabetes. It is, therefore, imperative that we advise people with diabesity on the importance of integrating physical activity into their lifestyles and offer practical advice as to how to do so.

As healthcare professionals we are all too aware of the far-reaching consequences of living an unhealthy lifestyle. The importance of participation in regular physical activity is highlighted in national guidelines for physical activity, which recommend that adults take part in 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity activity per week (World Health Organization [WHO], 2010). In the UK, these guidelines feature in practice recommendations for healthcare professionals, teachers, employers and local councils to name a few (NICE, 2008; Department of Education, 2013). Despite this widespread public health message, the increasingly "obesogenic" environment, with 24-hour availability of calorie-dense foods and wide-spread use of "energy-saving" devices for transportation, work and entertainment, has facilitated predominantly sedentary lifestyles (Aucott, 2008). Indeed, the number of people meeting the minimum recommendations for exercise is as low as 5% (Chaudhury and Esliger, 2011). The cultural shift away from habitual physical activity observed over the last century and a half has coincided with an increased prevalence of metabolic dysfunction and type 2 diabetes, which is now observed in all corners of the globe (Hu, 2011). It is, therefore, imperative that healthcare practitioners are able to educate people with diabesity about the importance of integrating physical activity into their daily lives, and provide them with the tools by which to do this.

The aim of this article is to present the evidence linking physical activity to health in order to reiterate the basis of the public health guidelines. It will then go on to discuss the place of physical activity in moderating the link between diabetes and obesity. Finally, it will discuss the efficacy of physical activity interventions and present suggestions for the implementation of physical activity advice in practice in order to facilitate behaviour change and produce the greatest benefits in health outcomes.

Habitual physical activity and health

Since the 1950s studies of Jerry Morris, who showed that bus conductors had a lower incidence of cardiovascular disease than their bus-driving peers (Morris et al, 1953), the link between physical activity and health has been well established. Cross-sectional studies have consistently demonstrated that individuals who engage in regular physical

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Article points

1. Since the 1950s studies of Jerry Morris, who showed that bus conductors had a lower incidence of cardiovascular disease than their bus-driving peers, the link between physical activity and health has been well established.
2. Several mechanisms by which physical activity improves glycaemic control without the need for weight loss have been identified.
3. Walking is a suitable mode of exercise for people with diabetes because it is accessible to most individuals and does not require specialist equipment or clothing.

Key words

- Physical activity
- Public health guidelines
- Walking

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Page points

1. Overweight and obesity are regularly associated with diabetes and as such the term "diabesity" has been coined.
2. Physical activity has been advocated as a way of increasing energy expenditure in order to create a negative energy balance and thus induce weight loss.

activity or who demonstrate higher levels of cardiorespiratory fitness (hereafter, fitness) are at lower risk of all-cause or cardiovascular mortality or both (Paffenbarger et al, 1986; Blair et al, 1989; Kodama et al, 2009), and morbidity, including diseases such as breast and colon cancer (Lee et al, 2011), cardiovascular disease (Thompson et al, 2003) and type 2 diabetes (hereafter, diabetes; Wei et al, 1999; Bassuk and Manson, 2005). Fitness levels also predict cardiovascular events in individuals at risk of diabetes (Yates et al, 2014) and cardiovascular risk factors in those who already have diabetes (Marwick et al, 2009). For example, an increase in physical activity of 2000 steps per day, roughly equal to 20 minutes of walking activity, has been associated with an 8% reduction in the risk of cardiovascular morbidity and mortality in those with a high risk of diabetes (Yates et al, 2014). Furthermore, in those with diagnosed diabetes, the risk of all-cause mortality is increased by a factor of 4 in those with low fitness (Church et al, 2005). This evidence highlights the benefits of engagement in "healthy" behaviours throughout one's life, but associations alone are not sufficient to support their role in the management of diabetes and metabolic dysfunction. Somewhat unusually for lifestyle factors, the full spectrum of research methodologies needed to infer causation has been applied in this area and the direct link between physical activity and its influence on glycaemic control is now well established.

"Diabesity"

Overweight and obesity are regularly associated with diabetes and as such the term "diabesity" has been coined. Figures from one hospital in England indicate that the prevalence of overweight and obesity in diabetes is 31% and 54%, respectively (Daousi et al, 2006). This compares with the proportion of the general population whose BMI is greater than 25 kg/m^2 and 30 kg/m^2, which in England is 37% and 25% for overweight and obesity, respectively (Moody, 2013). Overweight and obesity are associated with many of the same cardiovascular disease risk factors as diabetes including dyslipidaemia, hypertension, inflammation, insulin resistance and cardiac health (Klein et al, 2004; Poirier et al, 2006). These observations have led to weight loss being an important goal for those with diabesity; indeed the benefits of weight loss on outcomes related to diabetes are numerous and studies have suggested that for every 1 kg decrease in body mass, the risk of diabetes falls by up to 9% (Ford et al, 1997; Hamman et al, 2006). In line with this, interventions that have produced significant weight loss, usually following surgery or calorie restriction, have resulted in important health benefits including improvements in fasting glucose (Hu et al, 2001), insulin sensitivity (Goodpaster et al, 1999) and prevention or reversal of diabetes (Aucott, 2008).

While the benefits of weight loss are clear, clinically significant, sustained weight loss, often described as a 10% reduction in body mass for more than 12 months, is achieved only in a minority of individuals (Wing and Hill, 2001). Therefore, it is important to elucidate whether other health benefits can be gained in the absence of weight loss.

Physical activity as a treatment for diabesity

Physical activity has been advocated as a way of increasing energy expenditure in order to create a negative energy balance and thus induce weight loss. Contrary to popular opinion, weight reduction following exercise interventions is relatively modest and almost unachievable without planned dietary restriction, unless undertaken in a high dose of around 60 minutes of moderate physical activity per day (Miller et al, 1997; Wing and Hill, 2001). However, perhaps more important than total weight loss is the effect that physical activity has on body composition and fat distribution. Visceral fat is more metabolically active than subcutaneous fat (Ahima and Flier, 2000) and has been more strongly associated with diabetes and metabolic dysfunction than total body fat or BMI (Janssen et al, 2004). Although physical activity does not tend to reduce total body weight, it is consistently associated with changes in the way fat is distributed, particularly with reductions in visceral and hepatic fat storage, which help promote improved metabolic health even in the absence of weight loss (Vissers et al, 2013).

Perhaps because body weight provides a readily definable and easily measurable construct compared to physical fitness, not to mention the social desirability to be "slim", the positive effects of physical activity over and above weight management have been overshadowed. This is a paradigm that needs to be remedied as physical activity, in addition to reductions in visceral fat content, improves glycaemic control and delays complications of established diabetes independent of weight loss (Sigal et al, 2006; Telford, 2007). It also presents a low-cost intervention with many benefits beyond those related to diabetes and one that has no harmful side-effects (in the absence of underlying illness or injury).

Evidence from trials

Several landmark randomised controlled trials conducted from 1986 onwards have provided empirical evidence that lifestyle modification can reduce the risk of diabetes by around 50% (Pan et al, 1997; Tuomilehto et al, 2001; Knowler et al, 2002; Kosaka et al, 2005; Laaksonen et al, 2005; Ramachandran et al, 2006). These studies were seminal in providing evidence for a direct link between physical inactivity and development of diabetes, supporting and advancing the cross-sectional evidence that already existed (Gillies et al, 2007). A review pooling the results of these large trials suggested that lifestyle intervention incorporating physical activity could reduce the incidence of diabetes by 16% compared to control (Gillies et al, 2007).

Numerous trials designed to increase physical activity in participants with diabetes have also been conducted and produced improvements in glucose regulation despite no changes in parameters of body composition. A reduction of ~0.7% (7.6 mmol/mol) in HbA_{1c} is consistently observed following aerobic exercise training that meets the government recommendations, with greater benefit observed for interventions with higher volumes of physical activity (Boule et al, 2005; Snowling and Hopkins, 2006; Chudyk and Petrella, 2011; Umpierre et al, 2011). Cardiovascular risk factors such as hypertension, dyslipidaemia and inflammation are also improved following structured exercise training (Haskell et al, 2007; Archer and Blair, 2011), which is important because cardiovascular disease is the biggest cause of death in diabetes. Another interesting finding that emerged from these trials was that the effect on HbA_{1c} following lifestyle modification was comparable to that of pharmacotherapy, which offers no benefits other than on glycaemic control.

Effect on glycaemia

Several mechanisms by which physical activity improves glycaemic control without the need for weight loss have been identified. Insulin resistance, a condition recognised as a precursor to diabetes (Alberti and Zimmet, 1998), is reduced following both acute and long-term exercise training (Henriksen, 2002). The ability of physical activity to maintain insulin sensitivity is of utmost importance given that hyperglycaemia is a direct consequence of inadequate insulin signalling. The mechanisms by which physical activity facilitates insulin action tend to precede the reduction in blood glucose levels. For instance, mobilisation of muscle glycogen results in a short period of enhanced insulin sensitivity, which encourages muscle glucose uptake from the blood (Devlin, 1992). Exercise training also results in augmented circulation, which improves delivery of glucose to the muscles, enhancing glucose disposal (Ebeling et al, 1993). In addition, mobilisation of intra-cellular pathways and utilisation of muscle glycogen facilitates insulin signalling and glucose transport (Dengel et al, 1996; Colberg, 2006). These adaptations are responsible for the reduction of glycaemic excursions and insulin resistance, which are both positively associated with diabetes complications (Ceriello and Ihnat, 2010; Roberts et al, 2013).

While weight loss should by no means be discouraged, the evidence clearly demonstrates that engagement in physical activity and increases in fitness are as, if not more, important. In fact, the association between body weight and morbidity and mortality almost disappears when fitness is controlled for, whilst fitness emerges as a strong independent predictor of health (Church et al, 2004; Blair, 2009).

Walking: The best medicine?

Promotion of regular exercise has been one of the cornerstones of diabetes management for

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2. Insulin resistance, a condition recognised as a precursor to diabetes is reduced following both acute and long-term exercise training.
3. The term "exercise" can sometimes invoke negative reactions in sedentary individuals and be perceived as inappropriate or unacceptable.

"Encouraging goal setting and pedometer use are simple and practical ways to improve uptake and adherence to physical activity, while shifting focus away from weight loss as a measure of success is more likely to reduce feelings of failure, maintain motivation and ultimately lead to improvements in type 2 diabetes outcomes."

decades. Therefore, the challenge for healthcare professionals lies in the facilitation of behaviour change. Encouraging uptake of physical activity has proven difficult despite the widespread communication of the recommendations for exercise.

The term "exercise" can sometimes invoke negative reactions in sedentary individuals and be perceived as inappropriate or unacceptable. However, walking is a suitable mode of exercise for people with diabetes because it is accessible to most individuals and does not require specialist equipment or clothing. Walking has consistently proven to be the most appropriate and popular mode of exercise for those at risk of or with diabetes (Di Loreto et al, 2005; Health and Social Surveys Research Group, 2013). Importantly, for many, walking at a seemingly modest pace of 2.5 mph (4 kph) will feel brisk, which counts as moderate physical activity and thus results in improvements to health.

In order for healthcare professionals to successfully promote walking by their patients, it is important to recognise that individuals with diabetes are likely to face multiple barriers to exercise and, therefore, that changing physical activity levels will require substantial effort on the part of the patient. Findings from psychological theories of human behaviour change help explain why simply providing brief advice and informing individuals that they should be more active, as is the case in many healthcare consultations, is ineffectual. Behaviour change will only be achieved through a rigorous evidence-based programme, individualised for the patient.

The behaviour change technique taxonomy

The behaviour change technique taxonomy is a cluster of behaviour change techniques used in lifestyle interventions (Michie et al, 2013). Reviews of interventions incorporating these techniques have shown that the most successful interventions are those that combine traditional motivational approaches with robust and integrated self-regulatory strategies such as setting personalised goals, forming action plans and self-monitoring performance (Michie et al, 2009).

Pedometers (step counters) are a powerful self-regulatory tool in the promotion of increased walking as they raise awareness of current activity levels, provide objective feedback to the wearer and facilitate clear and simple goal setting. Interventions based on pedometer use have been shown to be highly successful at promoting increased physical activity in multiple populations, including those with diabetes (Bravata et al, 2007).

SMART goal setting is a useful tool for initiating behaviour change with individuals with diabesity. It is based on an individual's own starting points and allows them to make personal and realistic aims (Locke and Latham, 2006). SMART refers to specific, measurable, attainable, realistic and timely goals. These features prevent goals from being too generic and ambitious, which can be de-motivating and lead to failure. Other principles of goal setting, such as proximity (i.e. short- and long-term goals) and intrinsic versus extrinsic goals (i.e. results based on the individual rather than in comparison to somebody else) should also be implemented as people who have a chronic condition are likely to have baseline levels that are lower than the general population and will need to experience early success if they are to continue.

To take walking as an example, using a simple conversion, 3000 steps is roughly equivalent to 30 minutes of moderate-intensity walking (Tudor-Locke et al, 2011). In order to meet the minimum recommendations for exercise, sedentary individuals should eventually aim to increase their daily step count by 3000 steps per day. This should be achieved by breaking down this distal goal into proximal targets, such as staggered increases of 200 steps (or 2 minutes) per day every fortnight. These increments should be attainable for most individuals even when joint pain or other minor mobility issues are manifest.

One route through which the combination of pedometer use, goal setting and other behaviour change techniques have been successfully used to promote physical activity within the context of routine clinical care has been through structured education, particularly when used in the prevention of chronic disease. For example, the Walking Away from Type 2 Diabetes programme provides a 3.5-hour person-centred structured

education session for those at risk of chronic conditions, and it has been commissioned widely throughout the UK as part of routine diabetes prevention pathways or the NHS Health Checks programme (http://bit.ly/1wxTKTh [accessed 10.12.14]). The approach used in Walking Away has been shown to successfully promote increased walking of around 2000 steps per day (or 20 minutes of brisk walking) compared to control conditions and improve metabolic health over the longer term (Yates et al, 2009; 2011).

Conclusions

Physical activity has been one of the cornerstones of type 2 diabetes care since the epidemic began. However, despite universal acknowledgement of the importance of physical activity and the benefits it conveys, participation is alarmingly low. The challenge now is to identify and implement strategies designed to help improve uptake and adherence. Encouraging goal setting and pedometer use are simple and practical ways in which to facilitate this change, while shifting focus away from weight loss as a measure of success and celebrating other, fitness-related achievements is more likely to reduce feelings of failure, maintain motivation and ultimately lead to improvements in diabetes outcomes. ■

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