Chapter

SEDENTARINESS AND PHYSICAL INACTIVITY IN DIABETES: A CASE FOR HOME-BASED EXERCISE PRESCRIPTION

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ABSTRACT

Increasing proportions of the global population are being diagnosed with diabetes. It is anticipated that by 2030, 10% of the adult population worldwide will be living with this condition. Lifestyle factors can impact on the development, management and progression of diabetes. Obesity and sedentary living are contributory factors to the increased volume of diabetes. Physical activity offers those living with diabetes the opportunities to keep well and attain potentially more stable blood glucose control reducing the level of medical intervention required and delaying or preventing some of the life-changing complications that can derive from a diabetes diagnosis. Exercise interventions are effective in preventing and treating type-II diabetes. However, maintaining regular exercise routines, especially home-based exercises may provide a key for sustaining the health benefits.

Keywords: Type-II Diabetes, Glycaemic Control, Pathophysiology, Exercise Prescription, Exercise Adherence

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INTRODUCTION

Lack of physical activity is now an established cause of several chronic diseases including heart disease, diabetes, stroke, and cancer. Recent estimates of nearly 20 million cases of mortality caused by cardiovascular disease (CVD) (WHO, 2014) are a major concern, given that lifestyle related causes could be preventable. Therefore, it is important to understand the prevalence and causes of physical inactivity and sedentary lifestyle related health risks across different settings, and in different age groups, and to identify and to continue devising effective preventative and intervention strategies to enhance people's health.

Diabetes is a known major cause of premature mortality with high economic costs. Lifestyle behaviour changes into sedentariness and physical inactivity have been combined with a global epidemic of obesity and consequently an increase in many chronic diseases, including diabetes. Obesity is a significant contributory factor in the development of type-II diabetes; and obesity and type-II diabetes cases continue to grow at an alarming rate (WHO, 2015). Despite major steps taken to reverse the trend by public health strategies, there has been increased growth in patient numbers and Diabetes remains a significant cause of premature mortality (Public Health England, 2014). The diagnosis of diabetes is characterised by excessive hepatic glucose production; peripheral insulin resistance and defective beta-cells in the pancreas, with 90% of all cases in the UK, being determined as type-II (Diabetes UK, 2012).

This chapter provides an overview of the prevalence, health risks associated with diabetes, and the pathological consequences linking obesity and type-II diabetes. It also presents a specific insight into the exercise-based recommendations and potential benefits of physical activity and exercise, especially home-based exercise to prevent and manage type-II diabetes.

Overview of the prevalence and risk factors of diabetes

The risk factors for diabetes are mostly shared with obesity. Poor nutritional habits, including reduced calorific expenditure coupled with excess energy intake (calorie-dense, high sugar, high fat diets) has led to increased proportions of the adult population with reduced insulin sensitivity, most of whom are obese (Edelman, 1998; Lieberman, 2003). Truncal obesity, has been linked to raised levels of plasma leptin, fatty acids and tumour necrosis factor-alpha, this is thought to contribute to insulin resistance (Squires, 2001), and can accelerate ageing (Wolff, 1993).

The International Diabetes Federation has recently warned about the global epidemic of diabetes, with estimates of one in ten adults expected to have the condition by 2030 (IDF, 2014). The global prevalence of diabetes especially type-II diabetes, is no longer a problem solely for the developed western world such as the UK and US, but there is an emerging trend of increasing prevalence in developing countries, especially in Asia. On the one hand, Diabetes continues to rise in the US and UK - a 60% increase in diagnoses in the last ten years and a 10% rise in National Health Service spend on drugs to manage this condition (Diabetes UK, 2015). On the other hand, Asia is set to become the ‘epicentre’ of this epidemic with noted proportionally higher levels of young to middle-aged people being diagnosed with type-II diabetes (Shaw et al., 2010). The consequences of a diabetes epidemic are alarming. It is estimated that a diabetes-related mortality event is recorded every 7 seconds, and unfortunately it is thought that current statistics underestimate the true prevalence, with almost 50% of cases undiagnosed (IDF, 2014).

Sedentary causes of diabetes

Sedentariness is a major cause of obesity and being overweight, and is directly and indirectly linked with major chronic diseases especially cardiovascular disease (WHO, 2015). The highest prevalence of sedentary behaviour exists within the Americas and the Eastern Mediterranean, but globally 31% of the population is physically inactive. This accounts for 6% of world mortality; with 27% of deaths for those with diabetes attributed to low activity levels (WHO, 2011).

Sedentary behaviours such as watching TV and prolonged sitting hours are now known causes of diabetes (Hu et al., 2003; Matthews et al., 2008). Recent reviews have made a case for diabetes causes, amongst other chronic diseases, from sedentary behaviours, distinctly from that caused by physical inactivity (Dempsey et al., 2014). Whilst, a positive association exists between the incidence of type-II diabetes and television viewing time (Dempsey et al., 2014), those with diabetes have also been noted to take on average 2000 less steps per day (Liese et al., 2013).

A dose-response relationship exists between the volume of time of uninterrupted sitting and poor metabolic health (Owen et al., 2014). Approximately 55% of the waking day is spent on sedentary activity (Matthews et al., 2008) and those with diabetes are known to spend a larger volume of time being inactive when compared to their non-diabetic counterparts (Public Health England, 2014). Individuals who spend more than 10 hours a day sitting have a 34% higher all-cause mortality risk than those who spend just one hour of their waking day sitting (Chau et al., 2012). Therefore, reducing sedentary behaviour may require further action additional to that of promoting physical activity.

Fortunately, physical activity and exercise are now established measures to reverse the development and to treat type-II diabetes (Sigal et al., 2006). However, despite the known positive effects of physical activity in preventing and managing diabetes, the challenge remains to increase the level of habitual physical activity in those living with diabetes, and to do this in a cost-effective manner. This is particularly so in economically deprived areas, where currently there is estimated to be a 40% higher prevalence of diabetes (Public Health England, 2014). Multifaceted lifestyle interventions could involve physical, exercise training, nutritional and behavioural changes, and have been shown to provide cardiovascular risk-reduction benefits in high risk population groups (Alkhatib, 2015a; Klonizakis et al., 2013; Alkhatib & Klonizakis, 2014). Educational intervention towards an active and healthy lifestyle can involve exercise promotion, particularly in relation to weight management and energy expenditure, which can enable good management of the condition (Landry & Allen, 1992).

PATHOPHYSIOLOGY OF TYPE-II DIABETES

Diabetes is a metabolic disease characterised by insulin malfunction and impaired glucose control. Pancreatic Islet of Langerhans cells typically secrete lower levels of insulin resulting in higher circulating levels of blood glucose (Wolff, 1993). Type-II Diabetes Mellitus was previously termed Maturity Onset Diabetes Mellitus as a consequence of the increased prevalence noted in the middle years and the accumulation of lifestyle behaviours which are attributed to the development of the disease. While genetic and ethnic group predispositions to the disease have long been noted, the influence of maternal factors governing the intrauterine environment and foetal development are a more recent association (Inadera, 2013). Early life influences and behaviours derived from the environmental context are also additional considerations when investigating the aetiology of type-II diabetes (Zimmett et al., 2013).

Inflammatory mechanisms are thought to be significant in the development of type-II diabetes and atherosclerosis, with increased levels of the biomarkers tumour necrosis factor-alpha (TNF-α), Interleukin-6 (IL-6) and C-Reactive Protein (CRP) present in individuals with insulin resistance and abdominal obesity (Pradhan, 2007; Paolisso et al., 1998). TNF-α is thought to inhibit insulin receptor autophosphorylation and the levels of circulating TNF-α have been found to be four times higher in insulin resistant subjects (Saghizadeh et al., 1996). The presence of macrophages in adipose tissue is also noted in those with insulin resistance, especially TNF-α levels that have been found to be more than double in the adipose tissue of obese subjects, reinforcing the theory that inflammation is a significant contributory factor in the development of diabetes (Hotamislgil et al., 1993). Within the cell, JNK (Jun N-terminal kinase) and IKKβ/NF-κB (Ikappa kinase beta/nuclear factor kappaB) pathways are activated in the presence of pro-inflammatory receptors and block the normal signalling through insulin receptors. Reduction in internal responses can be compounded by magnesium binding defects within the cell, limiting a host of enzymatic metabolic reactions, adding to insulin resistance. Reduced dietary magnesium, and energy dense diets contribute to these cellular aberrations (Wells, 2008). Disordered metal metabolism (chromium, iron, copper) coupled with the cytotoxic effect of oxidative stress may cause abnormal islet function and lower insulin production (Wolff, 1993).

The decreased insulin release in response to consuming food is a cause of post-prandial hyperglycaemia which can contribute to hypercoagulation and the development of vascular complications. The obesity related peptides (adipocytokines) resistin and ghrelin can lead to higher baseline levels of E-selectin, intra-cellular and extra-cellular adhesion molecules which increase the likelihood of endothelial cell adhesion. There can also be a release of protein kinase, heightening production of basement membrane materials and increasing capillary permeability. The reduction in muscle contractions which accompanies more sedentary behaviour is thought to reduce lipoprotein lipase (LPL) expression negatively influencing high density lipoprotein (HDL) cholesterol production (Owen et al., 2010). This pathophysiology coupled with raised levels of free fatty acids, post-prandial hyperlipidaemia and increased production of free radicals contributes to atherosclerosis and cardiovascular disease (Skilton et al., 2005).

Unfortunately, type-II diabetes may go undetected for almost a decade, meaning that half of all patients already have one or more chronic complications by the time of diagnosis (Squires, 2001; Bell, 2001). A diabetes diagnosis carries a 25-fold increase in the risk of blindness, a 20-fold increase of a gangrene-related amputation and the same elevated odds for renal failure. Of those diagnosed with diabetes before the age of 30 almost half may not celebrate their 50^{th} birthday (Deckert et al., 1978). While the evolution of treatment protocols and increased health interventions may have improved these sobering statistics, cardiovascular disease is still the major cause of disability or death in those with the condition (AHA, 2012; Leong & Wilding, 1999). Acute and chronic complications of diabetes shorten lifespan, compromises quality of life and add to care costs (NICE, 2002). Diabetes is a disease that requires good self-management if the development of complications is to be minimised (Ramsing & Hill, 2007). Health behaviour is key to this, with heightened activity levels a contributory factor in improved disease status (Pigman et al., 2002).

BENEFITS OF PHYSICAL ACTIVITY FOR INDIVIDUALS WITH DIABETES

Individuals who are physically active are known to have lower blood pressure and heart rate, improved circulation, and less thrombotic episodes. Lower cholesterol, lower body mass indices (BMI), less body fat, higher metabolic rates and better weight control are further physiological benefits of exercising. Psychological benefits include increased vitality, reduced reporting of periods of stress and anxiety, mood elevation and heightened confidence. Enhanced mental faculties including improved memory have been noted, as well as better quality sleep. Exercise can also benefit an individual’s social life and reduce isolation. Those who regularly exercise are also less likely to be absent from work, a positive benefit for the economy (Goetzel et al., 2004). The capacity to maintain independence at home as a consequence of increased functional capacity can impact on quality of life and general happiness (Sharkey & Gaskill, 2013). Importantly, exercise is low-cost and side-effect free if safely prescribed (ADA, 2002).

Consequently, exercise is an advocated intervention for those at risk of, or living with type-II diabetes (ACSM, 2009). As well as the above benefits, exercise can reduce the risk of circulatory disease, aid weight control and reduce medication and health care costs (Hawkins et al., 2002). For example, moderate intensity exercise interventions have been noted to significantly reduce specific fat distribution in those with type-II diabetes thereby reducing cardiovascular risk (Jonker et al, 2013; AHA, 2012). Exercise (aerobic and resistance) can also significantly reduce glycated haemoglobin (HbA1c) levels, reducing microvascular problems (Squires, 2001; Pi-Sunyer, 2002) even in the absence of significant changes in body mass index (Boule et al., 2001). More recently, an 8 week passive static stretching intervention was noted to significantly reduce HbA1c levels in patients with type-II diabetes when compared to a control group, demonstrating that lower intensity activity can positively influence glycaemic control too (Seong, 2015). Unfortunately, those with type-II diabetes who do not exercise have been observed to have an almost 3-fold odds ratio for poor disease management (Pigman et al., 2002).

Exercise can significantly improve glycaemic control in diabetes (van Dijk et al., 2013). The body's sensitivity to insulin is heightened by physical activity as a consequence of the action of GLUT4 glucose transporters on plasma membranes and transverse tubules. A single bout of exercise can benefit the body's sensitivity to insulin for 16-18 hours because glucose is still being deposited in muscle tissue up to 2 hours post-exercise. Regular exercise increases the nature of GLUT4 glucose transporter actions. While the impact on blood glucose control can be experienced for 24-48 hours these effects have worn off 60-72 hours following exercise therefore the frequency of exercise bouts is key in maintaining good glucose control (Borghouts & Keizer, 2000; van Dijk et al, 2013).

EXERCISE PRESCRIPTION AND ADHERENCE FOR INDIVIDUALS WITH DIABETES

Aerobic endurance exercise has been the traditional exercise prescription for those with type-II diabetes, but it has been shown that combining this with resistance training gives added benefit in relation to positive physiological measures (Yavari et al., 2012). Current exercise recommendations for adults in the UK advocate doing aerobic exercise at a moderate intensity for 30 minutes on minimally 5 days (but preferably most days) of the week. This should be supplemented with strength-based exercise for the large muscle groups on at least two days of the week (NHS, 2015). However, the same health benefits can be derived by accumulating the moderate aerobic activity in 10 minute bouts. While an alternative adult exercise prescription of 75 minutes of vigorous aerobic activity (coupled with two days of strength training) also exists, the presumed low levels of fitness in people with type-II diabetes has meant that it is only in recent years that higher intensity exercise prescriptions have been tested in this population (Albright et al., 2000). While the generalisability of the outcomes of these studies are often hampered by small sample sizes the emerging trend is of the same positive physiological changes witnessed with moderate intensity interventions, but with the additional benefit of a lower volume of time spent exercising. Increased adherence to more vigorous forms of exercise employed within short term projects are noted when these are accumulated as a series of short bouts (Andersen, 1999). However, little empirical evidence exists of long term adherence to high intensity exercise protocols in contrast with that available for lower intensity exercise regimes.

Emerging literature has explored whether there may be a better time of day to exercise to heighten the impact on glycaemic control for those with type-II diabetes. While the evidence to date is limited, post-prandial resistance based exercise had a more positive effect on postprandial glucose and triacylglycerol concentrations (cardiovascular risk factors) when compared to the equivalent exercise routine being performed pre-prandially (Heden et al., 2015).

Current exercise prescriptions provide guidelines regarding frequency, duration and intensity of exercise – the mode will ultimately be dependent on accessibility, availability and personal preference. Applying the tenets of self-determination theory to the self-management of diabetes demonstrates that adherence to behaviour changes are more successful if the individual has been able to govern their own lifestyle choices rather than being pressured into implementation (Ramsing & Hill, 2007). Spousal support, if applicable, can be key in long-term adoption of health routines, with positive encouragement and the avoidance of being overprotective important features (De Ridder et al., 2005).

HOME-BASED EXERCISE ROUTINES FOR INDIVIDUALS WITH DIABETES

Physical activity can form part of daily routines in four ways – occupational, household, transport and leisure time (Gregory et al., 2007). Therefore, when considering the volume of accumulated movement that would derive health benefits then these four means should not be overlooked. With the exception of some aspects of the occupational setting, there is a degree of self-management required in relation to the volume, intensity and frequency of domestic, commuter and recreational activity and there may be a number of barriers that will need to be considered if metabolic benefits are to be conferred.

In the absence of an instructor-led intervention those who are returning to leisure-time exercise can lack confidence and knowledge regarding starting a routine and lifestyle behaviour change has been noted to be challenging for those with type-II diabetes (Simonavice & Wiggins, 2008; Ibrahim et al., 2002). The more effective change strategies focus on long-term management using professional support with the emphasis on the individual and their needs, utilising their support networks, and are community-based (Fox & Page, 2001; Daly et al., 2002; Duncan & Pozehl, 2002; Gordon et al, 2002; Cooper et al., 1999).

For those who have been sedentary for a long while then building up slowly is a safe and progressive exercise prescription to adopt. For example, starting with 5-10 minutes of activity per day for the first week, then adding on 5 minutes per day each week, till the target goal of 150 minutes of moderate activity is reached. Increasing the volume of walking and reducing the volume of sitting can be simple, and cost-free interventions. Pedometers are noted to be effective motivational tools to advancing volumes of walking-based activity (Minsoo et al., 2009). A baseline of 3000 steps/day can be used to build upon, adding a little more within the daily routine until the target 10,000 steps/day is reached (Welk et al., 2000). Many local authorities offer led-walks or exercise prescription schemes where there are the added benefits of an instructor and potential companions to support the adoption of a more active lifestyle. Circuit-based classes in either the home or in a community facility combine aerobic and resistance-based exercises.

Resistance bands such as (e.g. Therabands/dynabands) are user-friendly and portable forms of resistance equipment which can aid a gentle introduction to strength-based exercises (Hammond et al., 1997; Bethell, 1999; Leon, 2000). Increased compliance with community exercise interventions are observed when partners, friends or relatives can also participate (Hammond et al., 1997). Self-managed home-based routines similar to those illustrated in Figure 1 have been able to demonstrate exercise adherence and strength gains (Jette et al., 1999) with dropout reduced if there is supported instruction and guidance initially (Chan & Reid, 2013). Theraband exercises can recruit large muscle groups, complying with exercise recommendations (NHS, 2015) and can positively influence lower limb blood flow, a concern for those living with type-II diabetes (Egaña et al., 2010). Additional advantages of activity programmes using the exercises (or similar) outlined below (Figure 1) is that they enable family and friends to participate, require minimal equipment, and consequently little financial outlay.

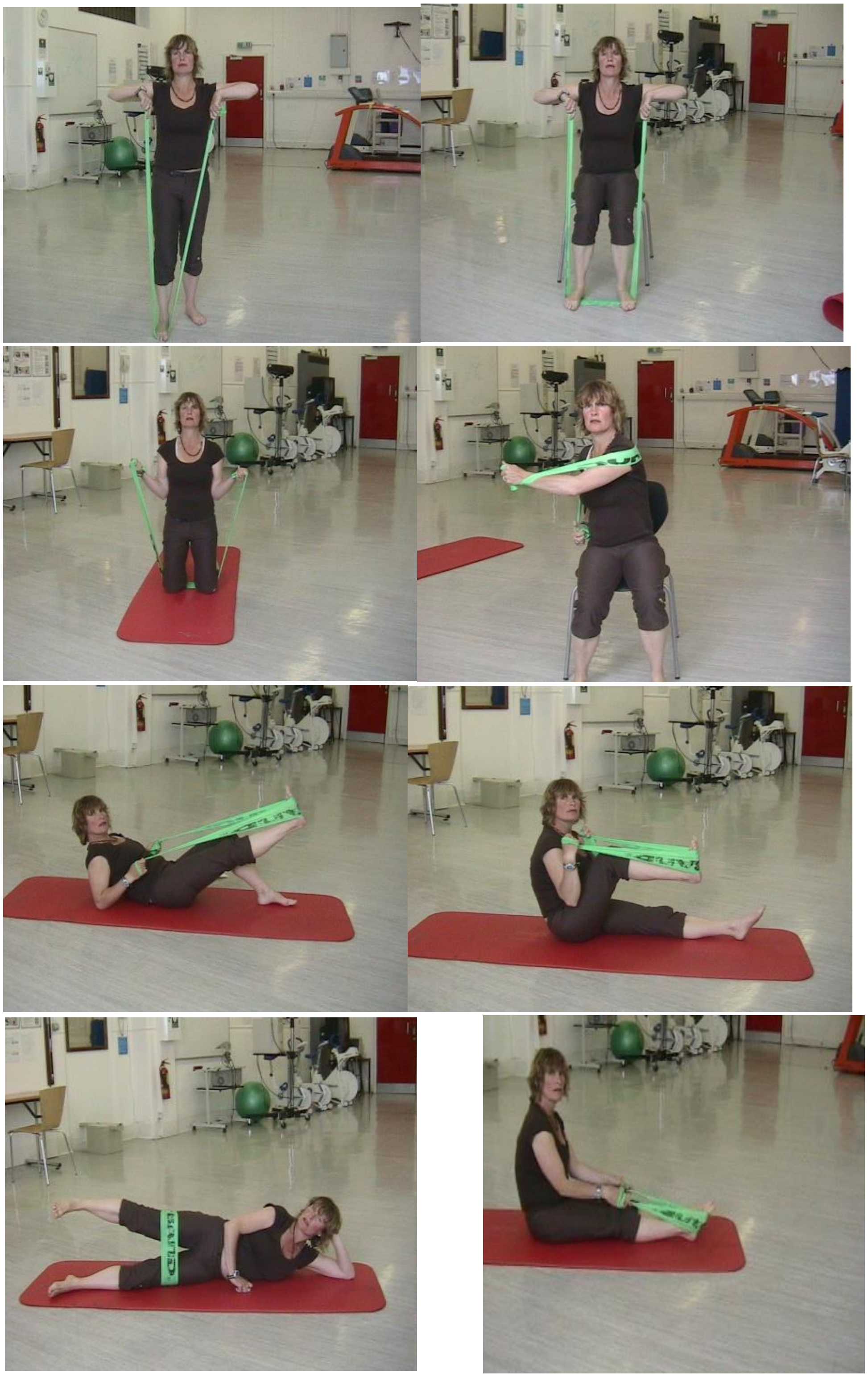

Figure 1. Illustrations of resistance exercises using resistance bands

Building short bursts of exercise into the daily routine is a time efficient way of getting the benefits of being physically active. For example, using the stairs instead of the elevator; parking a little further away from the intended destination; exiting public transport earlier. Building unstructured exercise into daily routines is thought to be a more effective means of increasing participation for those who would normally avoid structured exercise or sport (Hill & Williams, 2014).

Some household chores (Table 1) involve a level of energy expenditure which can positively impact on metabolism (Ainsworth, 2000). Higher, but moderate, calorific outlay can be derived from infrequent but necessary garden tasks, vigorous housework, or the more occasional house maintenance requirements. Less energy is spent on the more frequently deployed gardening and housework duties, but all have the capacity to confer the same benefits that can be gained from attending an exercise class, as they all involve aerobic and strength based activity. While acknowledging that those listed may not be performed on a daily basis (see also Table 2) they can contribute to the overall accumulated volume of physical activity and thereby enhance the health status of those living with diabetes (Nagasaki et al., 2014).

Table 1. The intensity of common household activities

Intensity	Gardening	DIY	Housework
Moderate Intensity	Digging; clearing rough ground; laying paths/slabs/bricks; using a hand mower over a large area; chopping wood/trees; or similar heavy manual work	Mixing/laying concrete, moving heavy loads, refitting a room or relocating heavy furniture; or similar heavy manual work	Carrying heavy shopping for more than 5 minutes; spring cleaning, scrubbing floors; cleaning windows, or other similar heavy housework
Light Intensity	Cutting the grass using a power tool; planting, hoeing, weeding, pruning	Painting and decorating; small repairs; washing/polishing/ repairing a car	

Most exercise prescriptions have concentrated on moderate (and more recently vigorous) forms of exercise. However, there is increased recognition of the need to spend less time sitting, particularly within the workplace (McCrady & Levine, 2009) and this is an aspect of occupational activity that can be self-managed. Reducing the volume of prolonged periods of sitting has demonstrated as favourable results as higher intensity modalities in relation to physiological biomarkers for those with diabetes (Dunstan et al., 2012; Duvivier et al., 2013). Indeed, moderate intensity exercise routines have been shown to be effective in high-CVD risk populations including reversing the sedentary related workplace risks (Alkhatib, 2015b; Alkhatib, 2015c) and the risks associated with sedentary older participants (Klonizakis et al., 2013; Alkhatib & Klonizakis, 2014).

The financial cost associated with exercise is a commonly cited barrier (Steenhuis et al., 2009) and this may be particularly so for some communities who are more predisposed to metabolic syndrome (Rimando, 2015). A home-based routine, can be a cheaper exercise choice as the potential supplementary costs, for example membership and transport, are removed. While hiring a personal trainer may seem an expensive option, it can be more affordable if it is a small group activity shared with family or friends. Providing the additional advantages of companionship and being instructor-led.

Green gym modalities of exercise generally involve little financial outlay and are increasingly advocated. The first projects were piloted more than a decade ago, and were found to not only benefit community health but the physical and mental health of the project participants (Reynolds, 1999). Initially, the term ‘green gym’ was used to describe public health interventions which focused on the community working on environmental/conservation causes. Typical projects included, creating more attractive green spaces, hedge clearing, footpath creation, development of allotments or community gardens. The proven association between the amount of green space in people’s environment and their health, led many local authorities to recruit volunteers to run community garden/flower projects, allotment associations or set up link-up schemes for home-owners with large/unmanageable gardens (charities for the aged/elderly also operate similar link-up schemes), (Maas et al., 2006).

However, the definition of the ‘green gym’ has been expanded to include individual exercise in the outdoors. Gardening is one such activity which would come under this expanded definition. Since the 18th century doctors have been prescribing gardening as a ‘therapy’ for its physical and mental benefits. The repetitive actions of bending, twisting and reaching all work on flexibility and balance; while the lifting and pulling associated with raking, digging and hoeing benefit strength-endurance, building muscle which can benefit the maintenance of independence as well as diabetic control (ACSM, 2009; Pine, 2006). Gardening is also known to enhance bone density and to improve emotional wellbeing and elevate mood (Rafkin, 2001; Austin et al., 2006). Gardening is a mixed intensity activity (Ainsworth, 2002) which can enable achievement of this goal, as supported by the energy expenditure detailed in Table 2.

Table 2. Calorific expenditure and gardening

Gardening Activity	Approximate kilocalories/hour
Clearing land/Digging	341
Using heavy power tools	409
Using a hand-mower	409
Using a power mower to cut grass (walking)	375
Picking flowers/fruit/vegetables	205
Manual Planting/Weeding/Trimming	307
Trimming using a power tool	239
Raking	293
Bagging garden rubbish	273
Hand-spreading fertiliser/grass seed	170
Watering plants	102

There is a growing body of evidence supporting the health benefits that can be derived from exposure to nature, particularly in relation to mental wellbeing. Spending time outdoors is known to improve mood, heighten concentration, and reduce stress and this is independent of the volume of exercise performed (Maas & Verheji, 2007; Pretty et al., 2007). Exposure to the elements can also enhance the body's Vitamin D levels which can be a bonus for those who have metabolic or weight problems (Florenz et al., 2007). Even experiencing the sights and sounds associated with nature has been noted to help pain control (Diette et al., 2003). Therefore if the individual works within their capabilities (see Table 3) but has other conditions alongside their diabetes this may be of further benefit.

Advice given to those undertaking individual (non-instructor-led) physical activity is that there should be some gentle preparatory warm-up, range of motion exercises that recruit the large muscle groups. Performing lower intensity movements at the outset of the session prepares the body for exercise by increasing blood flow and oxygen availability, raises muscle/ligament/tendon temperature enabling flexibility, and gently elevates heart rate and blood pressure (Rahl, 2010). Figure 2 gives some examples of appropriate exercises – squat and quadriceps stretches to prepare the thighs for lifting; the calf stretch to prepare the lower leg for pushing/pulling/lifting activities; and upper arms/shoulder stretch to prepare the upper body for pushing/pulling/lifting activities. These preparatory exercises confer exercise benefits for those with diabetes as a consequence of the enhanced blood flow (Egaña et al., 2010). However, it is also considered good practice to repeat these lower intensity range of motion exercises at the end of the bout of activity to assist the body to return to a resting state (Rahl, 2010). The warm-up/cool-down sections also provide metabolic benefits for those with diabetes, as regardless of mode or intensity, there is enhanced blood glucose control (Nagasaki et al., 2014).

Figure 2. Examples of warm-up activities

While modern means of monitoring the glycaemic state of the individual has advanced the exercise choices for those living with Diabetes, there are still a number of guidelines which are issued in order to ensure that exercise is performed safely (Table 3).

Table 3. Practical guidelines for safe exercise for those with Diabetes

Practical Recommendations for Exercising safely with diabetes
• Build up slowly – this is both within a single exercise session and also within the whole exercise programme.
• Don't ever try to lift maximum weights and never breath hold when doing any weight or resistance-based exercises.
• Don't try to do too much, stick to the exercise intensity which has been prescribed
• If new to exercise, monitor blood glucose before/during/after exercise until a routine is established.
• Check blood glucose levels if planning some DIY that involves climbing onto roofs/ladders.
• If doing any prolonged exercise or heavy household/gardening/DIY chores check blood glucose during the activity and adjust medication/food as necessary.
• If diabetes is controlled by diet alone, then no adjustment to food intake is required when exercising, unless undertaking for example, a marathon.
• Don't exercise when feeling ill, vomiting or with an infection.
• Get advice about exercising if pregnant – exercise is still advocated but previous prescriptions may need adjustment.
• Ensure that footwear isn't going to cause blisters and ensure good foot care.
• Remember general safety in the home when undertaking home-based chores – check for loose wires/rugs/obstacles; avoid hammering/drilling/sawing/mowing through any body parts/electrical cables and ensure that tetanus status is current.
• If there is a diagnosis of retinopathy additional advice may be required about the safest types of exercise
• If there is a diagnosis of autonomic neuropathy pulse and blood pressure may need monitoring during exercise.
• If there is a diagnosis of peripheral neuropathy weight-bearing exercises may have to be avoided.
• Going out alone while sailing, scuba-diving, rowing, power-boat racing, motorcycle racing, mountaineering, rock-climbing, parachuting, or hang-gliding is not recommended

Conclusion

While many studies have tested the efficacy of specific exercise interventions in this population no modality has emerged as the one to confer the most benefit. Instead the conclusion appears to be the best mode of exercise is the one that is most appealing and tolerant to the individual with type-II diabetes and the one that they will adhere to for the long term. Home-based, self-managed exercise routines are low-cost and can be built into daily routines removing time and finance barriers to establishing an exercise habit with derived metabolic gains.

Diabetes can accelerate ageing, impacting on functional capacity and independent living. An established schedule of physical activity can postpone this loss of functionality. A simple intervention can be just to reduce sitting time. Given the familial association of type-II diabetes, establishing exercise habits that can be cross-generational, involve a range of family members and can be role modelled, are further benefits of adopting a more physically active lifestyle.

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