PHYSICAL ACTIVITY AND METABOLIC DISEASE

BY DR PAUL BATMAN

It has been estimated that, by 2030, diabetes levels will escalate to one in three people contracting type 2 diabetes amid increasing overweight and obesity levels. With 68% of males and 60% of females at an unhealthy weight range, the number with diabetes will continue to increase and, by 2030, it is estimated there could more than 87,000 hospital cases every year.

Type 2 diabetes is a significant risk factor for cardiometabolic disease in the UK, with treatment costing approximately £8 million per year. Diabetes rates soared between 1994 and 2016 from 2.4% to 6.9% of the population, resulting in increases in the number of heart attacks, kidney failures and strokes.

Type 2 diabetes accounts for approximately 9% of the NHS budget, with 200,000 people every year being diagnosed with the condition. With the lockdowns associated with the COVID-19 pandemic, this number will reportedly escalate by over 98,000 new cases and an estimated 850,000 living with diabetes who are unaware of their condition placing an even greater strain on a healthcare system already struggling with services and costs.

Given these alarming statistics, a call to action has been prompted with the cornerstone being more education about diabetes prevention, programmes concentrating on maintaining a healthy weight, increase in physical activity and better food and diet choices.

One significant method for controlling diabetes is increasing physical activity levels. Historically, the national physical activity guidelines of 150 minutes of moderate to vigorous exercise at 3-9 METs has been the main intervention model. While very successful for mainstream symptom-free demographics, it can be too severe for vulnerable or sedentary groups, especially metabolic-deficient patients who generally present with poor muscle strength, reduced oxygen capabilities and neural problems associated with diabetes (40% of diabetes patients report neuropathies). Reaching these levels of intensity can be difficult for these patients, resulting in poor adherence or compliance rates. Some studies report 60-70% drop-out rates using this commonly accepted exercise prescription, highlighted by a drop-out rate of 65% in a 12-month walking programme.

Patients with type 2 diabetes also experience a low-grade inflammation causing the immune system to be hyper vigilant, releasing more white blood cells than is necessary and creating more free radicals that can eventually compromise the cell membrane and internal cell structures. When diabetics are subjected to prolonged bouts of inactivity, their inflammatory state can be further aggravated, contributing to the existing metabolic problem. Low-intensity activities of between 2-6 METs can assist with the control of inflammation and cause a reduction in the formation of free radicals in the cell, as well as improving insulin sensitivity and lowering plasma lipid levels.

To improve the cardiovascular and metabolic health profile of type 2 diabetics, the American College of Sports Medicine (ACSM) recommends an exercise prescription of low to moderate levels of intensity at 40-70% of maximum heart rate. It states that the lower intensity activity leads to a more comfortable and tolerable level of exertion, as well as reducing any potential musculoskeletal injury and feet/ankle trauma.

The purpose of this white paper is to investigate the role of different forms of physical activity of different durations and intensities and the influence of increased sedentary behaviour on the causes of metabolic disease.

RESEARCH REVIEW 1

Title: *Short-term decreased physical activity with increased sedentary behaviour causes metabolic derangements and altered body composition: Effects in individuals with and without a first degree relative*

Authors: Kelly Bowden, Victoria Sprung, Juliette Norman, Andre Thompson, Katie Mitchell, Jason Halford, Jo Harrold, John Wilding, Graham Kemp, Daniel Cuthbertson

Source: Diabetologia (2018), 61: 1,282-94.

Introduction

It is well established that physical inactivity significantly contributes to the development of obesity, insulin resistance and type 2 diabetes, generally caused by a reduction in muscle insulin sensitivity contributing to increased central fat accumulation in the liver and other organs.

The majority of studies examining inactivity have used interventions such as bed rest and limb immobilisation, while preventing exercise trained subjects from exercising. There have been few studies that have examined habitual activity in free living subjects. More recent studies focus on step reduction experimental models measured over a time period. The results of these studies report that a 14-day period of inactivity results in a decline in cardiorespiratory fitness, increased concentration of central fat, loss of skeletal muscle and a reduction in insulin sensitivity. Interestingly, these changes were reversed with the resumption of normal steps in the young but not in the older adult.

It has also been reported that parents, siblings and children of a person with type 2 diabetes have a three-fold increased risk of developing the disease.

This study aimed to investigate the metabolic changes that occur with a decrease in habitual physical activity and an increase in sedentary behaviour in the short term, and whether the same effects are likely to occur in their first-degree relatives.

Methods

Forty five habitually active subjects aged 36 +- 14 years who did not engage in formal exercise programmes were selected for the study. To be eligible, subjects had to have a daily step count >10,000 steps per day. Subjects were required to reduce their step count to 1,500 steps per day for 14 days. Data were collected on anthropometric measurements, glucose levels, HDL cholesterol, LDL cholesterol, insulin levels, total cholesterol and cardiorespiratory fitness (VO2 peak). Daily physical activity was measured with movement sensors that measured daily step counts, total energy expenditure and different levels of intensity. Dietary analysis was also made. At the end of 14 days, normal daily activity patterns were resumed before a final assessment.

Results

During the experimental period, daily step counts were reduced by 10,285 steps per day, while sedentary time increased by 223 minutes per day.

There were significant decreases in whole-body insulin sensitivity, cardiorespiratory fitness, lower limb muscle mass and muscle insulin sensitivity. There were increases in LDL cholesterol, total body fat and liver fat.

All changes were reversed after resuming normal habitual physical activity patterns.

Discussion

Although small initially, a short-term reduction in habitual physical activity as measured by >80% reduction in steps per day and an increase in sedentary behaviour can cause dramatic negative changes in cardiorespiratory fitness, insulin levels, central and liver fat levels and lean body muscle mass. The extent of the damage would be clinically significant over a longer inactive period. The rapid decline in metabolic health due to reduced activity and increased sedentary time supports the importance of lifestyle changes necessary to maintaining good health, even in the absence of a moderate to vigorous exercise regime.

Interestingly, first-degree relatives of type 2 diabetes patients appear to be more susceptible to these adverse changes in activity levels to a greater extent than those related to non-diabetic patients.

One of the major causes of decreased insulin sensitivity was the lack of continual muscle contractions that decreased the need for glucose uptake. Increased sedentary time reduced the metabolic demand of skeletal muscle, causing an increase in blood lipids as well as the storage of lipids in the adipose tissue in anticipation of a return to movement. Associated with the undesirable metabolic changes was overfeeding caused by the reduced energy expenditure.

The adverse metabolic changes and decrease in cardiorespiratory fitness were reversed after 14 days of the resumption of habitual daily activity, despite being formally untrained. This supports the need to maintain high levels of low- to moderate-intensity lifestyle activity and reduce sedentary time throughout the day.

RESEARCH REVIEW 2

Title: *Daily step count and postprandial fat metabolism*

Authors: Heath Burton, Edward Coyle

Source: Med Sci Sports Exerc. (2021), 53(2): 333-40.

Introduction

New information suggests that glucose tolerance and postprandial fat metabolism can be improved by a single bout of exercise but can be significantly affected by prolonged periods of inactivity.

With daily low- to moderate-intensity physical activity taken almost entirely out of every-day life, prolonged periods of sitting and inactivity have become routine. It has been reported that, even in the presence of 150 minutes of moderate to vigorous exercise per week, there is still an increased risk of developing cardiovascular disease and all-cause death through increased periods of inactivity and sedentary time and low step counts.

Walking has been regarded as a main intervention in breaking up inactivity and sedentary time, increasing cardiovascular fitness and improving cardiometabolic profiles. The 10,000 steps recommendation has been popular over the years as a prescriptive model for improving health and fitness and reducing cardiovascular events, while reducing step counts in as little as one week can reduce insulin sensitivity, glucose control, decrease VO2max, promote endothelial dysfunction, decrease muscle mass and increase abdominal fat. These effects can increase by 80% if reductions continue for more than two weeks.

Information is emerging that, when sitting for >14 hours and with a step count of only 1,650-3,750 steps per day, a 60-minute bout of running at 67% VO2max will not increase fat metabolism or clearance in the next 24 hours. It appears that, if moderate to vigorous exercise is preceded by prolonged periods of inactivity and sedentary time, the normal acute fat metabolism improvements expected of exercise are rendered less effective. This phenomenon has been termed 'exercise resistance'.

Normally after the consumption of a meal (postprandial) triglyceride levels in the plasma remain elevated for up to 10 hours, reaching a peak at approximately three to six hours after a fat-rich meal. The concentration and length of the fat elevation is affected by the previous physical activity undertaken. High fat circulating levels are known to contribute to reduced insulin sensitivity, type 2 diabetes, atherosclerosis and metabolic syndrome.

The purpose of this study was to investigate the effect of reducing step counts and a single 60-minute bout of moderate to vigorous exercise on postprandial plasma triglyceride levels and glucose levels, as well as fat oxidation.

Method

Ten subjects participated in the trial using different levels of step reduction. Subjects participated in five days of low (2,675 +- 314), limited (4,759 +-276) and normal (8,481 +- 581) steps per day. The first two days were control days that allowed for familiarisation, followed by two days of each step reduction level. At the end of each two-day intervention, subjects ran for 60 minutes at 64% VO2max on a treadmill. On the morning of day three after the treadmill exercise, subjects were given a high-fat shake and the postprandial effects were measured for the following six hours. Diets were controlled and subjects were asked not to undertake any other form of additional exercise.

Results

After the low (2,675 steps) and limited (4,759 steps) step days, plasma triglyceride levels remained high at 22-23% when compared to normal (8,481 steps). Whole-body fat oxidation was lower in low and limited step interventions compared to normal.

Discussion

The main finding of this study was that, when subjects reduced their step count to 2,675 and 4,759 steps, their plasma triglyceride levels were 22-23% higher and their whole-body fat oxidation was 14-19% lower than when they completed 8,431 steps per day. Abnormally postprandial high plasma triglyceride levels can lead to insulin resistance, glucose intolerance and type 2 diabetes.

This suggests that at between 2,500 and 5,000 steps per day there was still a blunting of fat oxidation and a reduced uptake of triglycerides into the tissues after 60 minutes of treadmill running at 64% VO2max. The blunting of triglyceride uptake and the decrease in fat oxidation by the tissues suggest that inactivity or reduced step count for two days before an exercise bout at a specific threshold might cause an inhibitory effect on postprandial fat oxidation, creating a potential exercise resistance.

In previous studies, it was observed that when step was reduced to <4,000 and sitting was >13 hours, the removal of triglycerides from the blood was significantly reduced after a 60-minute exercise bout. The higher prolonged sitting time that reduced intermittent muscle contractile activity created an environment where the full effects of the exercise bout could not be realised postprandial. A rate-limiting enzyme called lipoprotein lipase (LPL) is responsible for clearing triglycerides from the blood into the tissues. This enzyme is rendered inactive during prolonged sitting and can only be re-activated by low to moderate intermittent muscle contractions. The deactivating of the LPL enzyme during reduced muscle activity could be a contributing factor to the exercise resistance and the reduced fat metabolism. This supports the notion that even in those who participate in moderately high levels of activity and who still sit for prolonged periods increase their risk of mortality compared to those who exercise and are active throughout the day. It has been reported that, by breaking up sitting every hour with 20 seconds of intermittent cycling, fat metabolism increases, further limiting the exercise resistance effect.

RESEARCH REVIEW 3

Title: *Metabolic effects of breaking prolonged sitting with standing and light walking in older South Asians and white Europeans: A randomised acute study*

Authors: Thomas Yates et al

Source: J Geront A Biol Sci Med Sci. (2020), 75(1): 139-46.

Introduction

In over 50% of older adults who have diabetes or high blood sugar levels, 90% of the same group will present with high blood pressure or hypertension. Ageing significantly increases the risk of insulin resistance and glucose intolerance leading to type 2 diabetes, which is twice as prevalent in South Asian groups compared to white Europeans.

With sedentary time now comprising 50% of the waking day, high mortality and morbidity levels have been reported. Conversely, limiting sedentary time or breaking up prolonged sedentary periods has been associated with healthy ageing.

One major response reported from breaking up prolonged sitting has been the improved postprandial insulin sensitivity. The breaking up of sedentary time has been through intermittent standing or light walking.

The aim of this study was to investigate the short-term effect on postprandial metabolic responses by short breaks of standing or light walking in older adults and whether ethnicity is a major variable.

Method

Thirty South Asian women and 30 white European women aged 65-79 years were selected as subjects for this study. Both groups were subjected to three experiments: 1. Prolonged sitting for 7.5 hours while consuming two meals; 2. Standing for five minutes every 30 minutes for the duration of the test; 3. Five minutes of light-intensity walking every 30 minutes. There was a seven-day period between each testing protocol.

After each experimental period, blood samples were taken analysing glucose, insulin and triglyceride levels.

Results

Insulin responses were reported as lower in the walking intervention compared to standing. The lowered insulin response was significantly greater in South Asian women than in white European women.

Postprandial glucose response rates were lower in the light walking intervention compared to the standing breaks and there was no difference across ethnicity.

Blood pressure was lower after the light walking intervention.

Discussion

The results indicated that light walking for five minutes every 30 minutes of prolonged sitting resulted in clinically significant improvements in postprandial insulin levels, blood pressure and glucose levels. The greatest reduction in insulin levels was significantly greater in South Asian women, possibly due to the higher insulin levels they presented with at the initial testing.

Insulin resistance is a key marker of cardiometabolic disease with ageing and is a public health priority that could be controlled with five-minute walking breaks rather than a 30-60-minute MVPA exercise bout that is clearly beyond the ability of many older adults.

The light walking intervention produced a lower blood pressure response that is particularly significant, as increases in hypertension are a hallmark of ageing and contribute to increases in mortality rates. The walking intervention speed was 2.4-4.4km/h and is well within the ability of most older adults. The results suggest that the greatest benefit in breaking up sitting is achieved with some additional movement beyond just standing.

Breaking up prolonged sedentary time by standing had little effect on insulin levels and glucose levels in either ethnic group.

RESEARCH REVIEW 4

Title: *Brisk walking compared with an individualised medical fitness programme for patients with type 2 diabetes: A randomised controlled trial*

Authors: SFE Praet et al

Source: Diabetologia (2008), 51: 736-46.

Introduction

When combined with diet, exercise has been regarded as a key intervention in the control of diabetes and glycaemic control. The most commonly referred programme is a medical fitness-based programme consisting of a combination of aerobic activities and resistance training, usually supervised by an allied health professional.

The compliance rate for medical supervised programmes has been reported at between 10% and 80%, with financial costs sometimes beyond the affordability of many patients. An alternative programme consists of a low-cost group walking programme with an emphasis on aerobic activity with little resistance training. Some reports indicate that both aerobic and resistance training are necessary components of a successful intervention to control diabetes.

The purpose of this study was to compare changes in glycaemic control and cardiovascular risk after 12 months of a low-cost group brisk walking programme compared to the more traditional medical fitness model.

Method

From an initial cohort of 493 diabetic patients, 92 were randomly allocated to either a brisk walking or medical fitness intervention for a 12-month period.

The brisk walking group met three times per week for 60 minutes per session at an intensity of 5-6km/h, reaching 75% of maximum heart rate. All sessions were supervised by a certified fitness trainer. A resistance training protocol was introduced that consisted of bodyweight, floor and elastic band exercises.

The medical fitness group met for three 30-minute exercise sessions per week and performed an interval-style protocol on a home trainer, elliptical trainer or rowing ergometer, based on their physical work capacity. The intensity was at 73% of maximum heart rate. They also participated in a resistance training programme consisting of eight exercises for both upper and lower body. After six months, the duration of the programme increased from 90 minutes per week to 180-225 minutes per week.

Energy expenditure, resting heart rate, blood pressure, cardiovascular fitness and blood analyses consisting of HbA1c (haemoglobin and glucose combined is an indicator of blood sugar levels), plasma glucose, insulin, HDL, LDL and total serum cholesterol were recorded.

The financial cost to the subject was €853 for the medical fitness programme, compared to €396 for the group brisk walk programme.

Results

At the end of the 12-month programme, 37% of the brisk walking programme and 44% of the medical fitness group were still actively participating in the programme. The main reasons cited for dropping out of the programme were lack of motivation and lower-body overuse injuries and arthritis.

There was no significant difference in glycaemic control as measured by the HbA1c between either of the brisk walking or medical fitness programmes.

There was no significant difference recorded for blood pressure or resting heart rate between both intervention groups.

There was no change in body composition and no significant differences between fitness levels and workload capacity.

Discussion

This study reported that a group brisk walking programme could produce equally significant changes to an individual supervised medical fitness model over a 12-month period.

One major concern was the significant drop-out rate in both interventions. The main reasons given were lack of motivation and lower-body overuse injuries and orthopaedic problems. In diabetic groups, it has been reported that high drop-out rates are mainly due to neuropathies and poor muscle strength and sarcopenia.

A recommendation was that the initial intensity was too great and the progression should have been more gradual, with an initial emphasis on resistance training and flexibility to ensure that muscles and tendons are capable of withstanding the significant stress of more intense exercise. Another possible intervention would be to set a daily workload that is reached by performing every-day activities at a more comfortable level of intensity.

If compliance or adherence is a risk in longer programmes, more time must be spent in mentoring and individual counselling to ensure long-term clinical benefits.

RESEARCH REVIEW 5

Title: *Association between bout duration of physical activity and health: A systemic review*

Authors: JM Jakicic et al

Source: Med Sci Sports Exerc. (2019), 51(6): 1,213-19.

Introduction

A barrier to exercise that is often cited is lack of time. While there is no dispute that moderate to vigorous exercise is the cornerstone of an improvement in health, adherence rates are historically poor. The compliance with a 30-minute bout of exercise performed for five days totalling 150 minutes of MVPA has been outside the ability of most people with chronic conditions, particularly those with metabolic disease.

More recently, there have been emerging reports that multiple shorter bouts of exercise of <10 minutes accumulated over the day could produce favourable health benefits.

Maintaining exercise sessions long term has been difficult for diabetics due to neuropathies and poor muscle strength levels.

Global physical activity guidelines over the last decade recommended that the exercise bout duration >10 minutes is the tipping point for health improvements. However, with improved instrumentation, the 2018 Physical Activity Guidelines Committee (PAGAC) recognised that activities of daily living were rarely performed for more than 10 minutes at a time.

The 2020 World Health Organization, for the first time in its landmark Sedentary Behaviour and Physical Activity Guidelines, advocated that bouts of exercise of fewer than 10 minutes in duration should now be included in exercise prescription for health.

Method

The PAGAC conducted an extensive meta-analysis reviewing 25 original manuscripts from 1995-2017 that investigated the relationship between bouts of physical activity and specific health outcomes. They specifically examined the relationship between bouts of exercise >10 minutes compared to <10 minutes on bodyweight, blood lipids, blood pressure, glucose levels, insulin levels and metabolic syndrome.

Results

There was no significant difference between the accumulated (<10 minutes) and continuous exercise bouts on blood pressure and total cholesterol, C-reative protein (inflammatory marker), insulin levels, metabolic syndrome and all-cause mortality. Lower fasting blood glucose levels were reported in the accumulated <10 minutes bout. HbA1c levels, which are a marker of diabetes, were lower in the accumulated 10-minute bout than the continuous bout.

Discussion

This study highlights the significant shift away from exercise bouts >10 minutes required to receive any major health benefits and all-cause mortality to <10-minute bouts. This is of particular importance for public health messaging, allowing people to accumulate physical activity of shorter durations in any form over the course of the waking day.

The main type of physical activity that appears to produce the most effective results is walking. Unlike many other forms of exercise, walking has no cost and can easily be incorporated into daily life to meet exercise guidelines.

In a lockdown situation created by the COVID-19 pandemic, sit to stand to stroll transitions have been prescribed with great success. People were asked to stand and stroll from a sitting position every hour for five minutes for at least 12 hours per day. This translated into 60 minutes of activity at 3 METs for 60 minutes, totalling 180 MET Minutes. If this was performed every day 180 x 7 = 1,260 MET Minutes, which is well in excess of the 500-1,000 MET Minutes recommended by the WHO.

RESEARCH REVIEW 6

Title: *Enforced inactivity in the elderly and diabetes risk: Initial estimates of the burden of an intended consequence of COVID-19 lockdown*

Authors: Courtney Kipps, Mark Hamer, Neil Hill, Paula Lorgelly

Source: June 2020, doi:10.1101/2020.06.06.20124065

Introduction

As a means of controlling the transmission of COVID-19, countries throughout the world adopted 'stay at home' orders, only permitting people to leave their homes for food buying, healthcare and to exercise once per day. In the UK, those older adults >70 years who have been identified as at particular risk were advised to stay at home for at least 12 weeks.

As a consequence of the stay at home order, many medical treatments and appointments were cancelled in order to abide by the strict isolation orders. The lockdown closed many facilities that older adults would normally frequent to remain active.

Physical activity has been recognised as a key intervention against chronic disease and all-cause mortality. Generally, those who are habitually active live longer and healthier, maintain their independence and have lower healthcare costs, while the inactive have higher rates of chronic disease and healthcare costs.

While social distancing, self-isolation and lockdowns have been a major controller of the transmission, there appears to be a price to pay in older adults' general health.

The potential benefits of physical activity sadly can be lost much faster than it takes to attain them. In as little as one to two weeks of inactivity, VO2max and glucose control can be adversely affected, making it an independent risk factor even in lockdown.

Type 2 diabetes is a significant risk factor for cardiometabolic disease in the UK, with treatment costing approximately £8 million per year. Diabetes rates soared between 1994 and 2016 from 2.4% to 6.9% of the population.
This study estimated the cost of inactivity during lockdown on the diabetes risk of older adults and the healthcare costs associated with it.

Methods

This study focused on the older adults with pre-diabetes during lockdown. It estimated the new number of new diabetic cases, total costs and future financial burden, the number of pre-diabetics who were active and the relative risk of diabetes.

Results

The Office of National Statistics estimated that there were 9,006,762 people over the age of 70 years in the UK in 2019, with 1.555 million having HbA1c values ranking them as high risk for diabetes (pre-diabetic). As a result of lockdown and inactivity in the >70 years group, it was estimated that there would potentially be 392,948 new cases.

The healthcare costs to screen and test these new cases was estimated at £35 million and their subsequent treatment and prescriptions at £225 million. The additional cost of treating complications in this group progressing to full diabetes was £909 million. The total NHS cost was estimated at £1.17 billion, which does not include indirect costs, social care costs and the loss of productivity.

Discussion

The interventions used to limit the transmission of one pandemic have inadvertently led to the development of another pandemic, which may prove to be as costly in both lives and financial costs.

The other unintended healthcare costs of COVID-19 include postponement of elective surgeries, morbidity costs associated with long COVID-19 recovery, decrease in patients attending medical consultations and inpatients, all of which carry significant additional costs.

Type 2 diabetes accounts for approximately 9% of the NHS budget, with 200,000 people every year being diagnosed with the condition. This number will escalate due to lockdown by over 98,000 new cases. Diabetes can be controlled with diet, medication and physical activity.

During lockdown and throughout the developed world, exercise was widely promoted as an important intervention in improving the immune system functioning to help control the effects of COVID-19. However, while some age groups might have taken the opportunity to become active initially, it seems that as the lockdown continued there was a reduction in exercise habits in most demographics. The older adults >70 years who needed physical activity the most seem to have become the least active and the most vulnerable, not only to COVID-19 but also to the ravages of inactivity and an increased sedentary lifestyle.

For exercise to have been effective in controlling COVID-19 and subsequent inactivity, new and more lifestyle-based physical activity interventions should have been promoted. Greater awareness of low- to moderate-intensity intermittent muscle contractions, how to create active homes, active transport, active work and active leisure would have given the population more options to become more active and reduce sedentary behaviour now and in the foreseeable future.

RESEARCH REVIEW 7

Title: *Minimal intensity physical activity (standing and walking) of longer durations improves insulin action and plasma lipid more than shorter periods of moderate to vigorous exercise (cycling) in sedentary subjects when energy expenditure is comparable*

Authors: Bernard M Duvivier et al

Source: PLoS One (2013), 8(2): e55542.

Introduction

It has been well established that prolonged sitting results in increases in all-cause mortality and sedentary-related diseases such as glucose intolerance, increased plasma lipid concentration and increased insulin insensitivity. Prolonged sedentary time has been identified as an independent risk factor.

Reducing habitual physical activity by 15% in a two-week period can reduce glucose uptake by 17%. Insulin sensitivity is an important variable in the development of type 2 diabetes and is adversely affected by muscle inactivity due to an increase in skeletal muscle insulin resistance. Contracting skeletal muscles assist with the removal of glucose from the blood and reduce the need for large increases in insulin resistance from the pancreas.

The most common prescription to improve the cardiometabolic profile and reduce the risk of diabetes is 150 minutes of moderate to vigorous intensity exercise per week. It has been reported that this prescription is out of reach of most older adults and perhaps a different approach towards reducing sedentary time could be used as an initial prescription.

The purpose of this study was to investigate whether the negative metabolic effects of too much sitting could be attenuated by 60 minutes of MVPA daily exercise.

Method

Twenty mostly sedentary subjects who volunteered for this study were aged between 18-30 years with a BMI of 20-30kg/m2. Subjects had to follow three activity programmes for four days each.

Subjects had to sit for 14 hours per day, walk for one hour per day, stand for one hour per day and sleep for eight hours per day. In the exercise protocol, subjects sitting for one hour per day was substituted with one hour of exercising while the rest of the day was the same as the sitting group. In the minimal-intensity programme, subjects were asked to replace six hours of sitting with four hours of walking and two hours of standing. Between each activity programme there was a 10-day break. Physical activity was monitored by a tracking device and diary.

Measurements were taken on insulin sensitivity and plasma lipid levels in a fasting state. Triglycerides, non-HDL and LDL levels were also measured.

Results

Insulin sensitivity levels were lower and triglycerides and non-HDL were also reduced significantly after the minimal-intensity activity protocol, compared to sitting and exercise protocols.

Discussion

Many new studies are prescribing 60-75 minutes of MVPA exercise to reduce the long-term cardiovascular problems associated with prolonged sitting. While not eliminating the side effects entirely, this prescription reduces the impact of prolonged sitting on mortality rates and cardiovascular health. While this prescription might be successful in reducing risk factors, it is difficult to maintain on a day-to-day basis and very difficult particularly for those suffering from metabolic disease.

It seems plausible that, to remedy the metabolic side effects of prolonged sedentary time such as insulin resistance and increased plasma lipids, more intermittent multiple contractions over the course of the day might be required in addition to the MVPA 150 minutes recommendations. Intermittent muscle contractions provide the stimulus to activate LPL enzymes important to extract triglycerides from the blood into tissues and the GLUT 4 transporter necessary for the removal of excessive blood sugar. A single continuous exercise session appears to be less effective in reigniting the LPL enzyme and Glut 4 transporter.

A confounding problem with 30 minutes per day for five days is the poor compliance that diabetic patients typically report from traditional exercise programmes. Factors such as reduced muscle strength and neuropathies reported in 44% of diabetic cases make it difficult to adhere to long-term exercise prescription of longer durations. Diabetic patients also report difficulty in sustaining an exercise habit due to lack of motivation and lack of time. A study reported a 65% drop-out rate in type 2 diabetics when exercise was based on 150 minutes of MVPA per week. Given that it has now been included in physical activity guidelines, activity sessions <10 minutes' duration and accumulated over the day could be a more realistic prescription and long-term option.

RESEARCH REVIEW 8

Title: *Sedentary activity associated with metabolic syndrome independent of physical activity*

Authors: Andrea Bankoski et al

Source: Diabetes Care (2011), 34.

Introduction

Perhaps the fastest-growing non-communicable disease over the past 30 years in the world is type 2 diabetes. The precursor to diabetes, heart disease and stroke is metabolic syndrome. This is a cluster of conditions that include abdominal obesity, high triglycerides, hypertension, low HDL cholesterol and hyperglycaemia. The criteria for suffering from metabolic syndrome are having three conditions from the cluster.

One risk factor for metabolic syndrome often identified is physical inactivity, defined as an absence of moderate to vigorous physical activity. With the increasing prevalence of sedentary time, new studies that differentiate sedentary behaviour from physical inactivity report it having its own set of conditions that are different from a lack of moderate to vigorous exercise.

The more time spent in sedentary behaviour, the greater the risk of metabolic syndrome, while breaking up prolonged sedentary time reduces these risk factors, indicating that the time spent being sedentary is associated with poor health outcomes independent of an MVPA exercise programme.

The purpose of this study was to investigate the effect that sedentary behaviour has on metabolic syndrome in adults >60 years.

Method

A sample size of 1,369 older adults was originally selected for this study, of which 665 were identified with metabolic syndrome, all obtained from the NHANES database. Data was collected from an interview, medical examination and a laboratory test. Activity levels were measured using accelerometry, waist circumference, serum triglycerides, HDL levels, fasting glucose levels and blood pressure, which was taken for all subjects.

Results

Subjects spent approximately 95 hours in sedentary behaviour. Those with metabolic syndrome were women, lower educational level, mainly non-drinkers, higher BMI, spent less time at MVPA intensity, had lower accelerometer counts during active minutes of the day, had longer sedentary bouts, had lower intensity during sedentary bouts and had fewer sedentary breaks.

When adjusted for age, sex, ethnicity, education, alcohol, smoking, BMI, diabetes, heart disease and physical activity, higher sedentary time with fewer active breaks was associated with increased risk of metabolic syndrome.

Discussion

People with metabolic syndrome spend more time in sedentary behaviour, have longer sedentary bouts, spend less time in MVPA and have fewer breaks in their sedentary periods, indicating a strong association between the number of sedentary hours and the increased risk of metabolic disease. This is one of the first studies to show this relationship, as many previous reports have found that physical activity predicts metabolic risk.

The results of this study suggested that it is not only total sedentary time that increases metabolic risk but the patterns of sedentary time, indicating that while a reduction in total sedentary time is important, so too is breaking up the existing time into smaller sedentary segments and increasing general movements throughout the day.

Older adults appear to be more at risk in becoming sedentary and developing metabolic syndrome. Currently, the fitness landscape does not attract this demographic in significant numbers, even though they are the fastest-growing demographic and cost the healthcare system more than any other age group.

RESEARCH REVIEW 9

Title: *Effects of a home-based intervention on diet and physical activity for rural adults with or at risk of metabolic syndrome: a randomised controlled trial*

Authors: Krysten Blackford, Jonine Jancey, Andy Lee, Anthony James, Peter Howat, Tracey Waddell

Source: International Journal of Behavioural Nutrition and Physical Activity (2016), 13: 13.

Introduction

It has been reported that 13-35% of adults in countries such as UK, Australia and US have metabolic syndrome, with the prevalence increasing with age. The main risk factors for metabolic syndrome and cardiovascular disease include high cholesterol levels, overweight/obesity, physical inactivity, high blood pressure, poor diet and a sedentary lifestyle.

Over 90% of Australians reportedly are not eating enough servings of vegetables, 51% are not eating enough fruits and 60% did not meet the 150 minutes of physical activity recommendation per week.

The numbers between the advantaged and the disadvantaged groups are widening, with lower socioeconomic groups more likely to be inactive, sedentary, have abnormal glucose levels, and lower fruit and vegetable intake compared to more affluent groups. This is amplified in rural communities, where there are higher mortality rates and poor access to healthcare services. Rural groups are more likely to be older >65 years, obese/overweight, have metabolic syndrome and suffer from chronic diseases, highlighting the need for an increase in health programmes and services to these regions.

The Albany Physical Activity and Nutrition Program (APAN) was developed to improve dietary and physical activity behaviours in 50-69 year-old adults.

This study aimed to investigate whether the APAN programme could improve the physical activity, diet and sedentary behaviours in older adults in remote communities.

Method

There were 401 subjects aged between 50 and 69 years who were diagnosed at risk or with metabolic syndrome recruited to participate in a six-month randomised controlled trial. Subjects were screened by the Type 2 Diabetes Risk Assessment, assessed for waist circumference, dietary assessment, fasting blood samples and blood pressure and then were divided into an intervention group or control group.

The intervention group performed a home-based programme specifically addressing fitness levels and lifestyles. The fitness programme followed the national guidelines and dietary requirements. This group also received constant motivation with telephone support, online materials, goal setting and email communication. Self-determination theory was a major contributor to the motivational framework used in this study, stressing the value of new behaviours and intrinsic motivation. APAN materials were provided, stressing self-monitoring and goal setting and promoting the Australian Physical Activity and Sedentary Behaviour Guidelines that had previously been validated. Materials included booklets, charts, resistance bands, exercise charts, nutrition information, progressive checker and interactive blog.

Results

At the beginning of the study and during the selection process, there were no differences between the intervention group and the control group. The intervention group demonstrated significant improvements in mean walking time (MET minutes) per week, sitting time (reduced) and strength compared to the control group, who reduced their physical activity time and became more sedentary. Significant improvements were also noted in fibre intake, reduced fat intake score, increased fruit intake and increased vegetable intake.

Discussion

Interventions that address physical inactivity, poor diets and sedentary behaviour are becoming more important to reduce the risk of metabolic syndrome and cardiovascular problems.

The physical activity prescription for this study was based on national guidelines of 150 minutes of MVPA per week, which proved successful in reducing inactivity levels and producing positive health results. The many motivational techniques used provided support throughout the six months and contributed to the significant result. While there was an increase in physical activity levels, the reduction in sedentary times was not as significant. More education could have been provided on the problems of prolonged sitting, as it was limited with the emphasis being on improving activity levels.

A strength of this study was the self-determination approach to becoming active by creating an environment where new habits could be made. The major components of self- determination theory are to make the new behaviour option convenient so that it can be performed at a convenient time and place, be competent to be able to perform the new behaviour, have a purpose that is gained by performing the activity and enjoying the movement experience.

This study showed that it is possible to provide a low-cost, home-based option with motivational support to improve the metabolic health and cardiovascular health of rural and remote communities.

RESEARCH REVIEW 10

Title: *How does light-intensity physical activity associate with adult cardiometabolic health and mortality? Systematic review with meta-analysis of experimental and observational studies*

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Introduction

Over the past 20 years, health promotion programmes and public health guidelines have promoted moderate to vigorous exercise at a 3-6 MET intensity as the mainstay for improvements in high blood pressure, blood lipids, blood glucose, obesity and mortality.
Little attention has been paid to other physical activities performed at low intensity between 1.6-3 METs. These activities include walking, household chores, gardening and other lifestyle activities.

Given the poor adherence rates for formal fitness programmes, particularly amongst those with chronic diseases including metabolic disease, light-intensity physical activity might be a viable alternative as it does not require dedicated time commitments or attendance at specific venues.

The aim of this study was to investigate the effect of light-intensity physical activity (LIPA) on cardiometabolic health.

Methods

Researchers in this study conducted a systemic review of databases to identify relevant observational and experimental studies that investigated between LIPA and cardiometabolic health markers and all-cause mortality in adults. Finally, 72 studies were eligible, including 27 experimental and 45 observational studies.

Results

The mechanistic studies reported that short bouts of light-intensity activity throughout the day reduced postprandial glucose levels and insulin levels. The experimental studies revealed that daily intermittent light-intensity activity reduced the risk of all-cause mortality.

There was less conclusive evidence that light-intensity physical activity reduced blood pressure levels and blood lipid levels. This could possibly be due to the low volume of light-intensity physical activity of the studies. To receive strong cardiovascular benefits, moderate-intensity activities reportedly produce the strongest response. If light intensity is used as a substitute, a larger volume of work is needed to create a similar stimulus.

Discussion

Participation in low-intensity physical activity causes important positive benefits in cardiometabolic health. To produce stronger changes in blood pressure and lower mortality risk factors further, a greater volume of low-intensity work needs to be completed to at least equal the workload of the MVPA intensity. Different chronic diseases require different doses of physical activity. One size does not fit all.

The use of light-intensity physical activity can cause significant improvements in insulin and glucose metabolism and lowering mortality risk, particularly when MVPA is difficult to sustain long term. Light-intensity physical activity is an important option for some populations, including the elderly, obese, overweight, metabolic syndrome and other chronic conditions that make movement difficult. Reports indicate that the effects of light-intensity physical activity can be stronger in those who are metabolically unhealthy and sedentary. It also has great application in those who struggle with motivation in undertaking an MVPA programme.

Given that the problems of prolonged sitting cannot be entirely reversed in MVPA, adding light-intensity physical activity to the programme would reduce sedentary time through intermittent muscle contractions throughout the day.

One biological mechanism used to explain the success of light-intensity physical activity is the improved activation of the lipoprotein lipase (LPL) enzyme responsible for improving the blood lipid profile by transporting triglycerides from the blood into the tissue. LPL enzymes are activated with muscle contractions and generally become dormant during sedentary behaviour longer than 30 minutes.

Frequent bouts of low-intensity physical activity should become an integral part of any fitness programme to reduce sedentary time and break up prolonged sitting, while incorporating additional MVPA when appropriate.

THE BOTTOM LINE

1 Although small initially, a short-term reduction in habitual physical activity as measured by >80% reduction in steps per day and an increase in sedentary behaviour can cause dramatic negative changes in cardiorespiratory fitness, insulin levels, central and liver fat levels and lean body muscle mass. The extent of the damage can be clinically significant over a longer inactive period. The rapid decline in metabolic health due to reduced activity and increased sedentary time supports the importance of lifestyle changes necessary to maintaining good health, even in the absence of a moderate to vigorous exercise regime.

2 When subjects reduced their step count to 2,675 and 4,759 steps, plasma triglyceride levels were 22-23% higher and their whole-body fat oxidation was 14-19% lower than when they completed 8,431 steps per day. Abnormally postprandial high plasma triglyceride levels can lead to insulin resistance, glucose intolerance and type 2 diabetes. This suggests that at between 2,500 and 5,000 steps per day there was still a blunting of fat oxidation and a reduced uptake of triglycerides into the tissues after 60 minutes of treadmill running at 64% VO2max. The blunting of triglyceride uptake and the decrease in fat oxidation by the tissues suggest that inactivity or reduced step count for two days before an exercise bout at a specific threshold might cause an inhibitory effect on postprandial fat oxidation, creating a potential exercise resistance.

3 Light walking for five minutes every 30 minutes of prolonged sitting results in clinically significant improvements in postprandial insulin levels, blood pressure and glucose levels. The greatest reduction in insulin levels appears significantly greater in South Asian women, possibly due to the higher insulin levels they presented with at the initial testing. Insulin resistance is a key marker of cardiometabolic disease with ageing and is a public health priority that could be controlled with five-minute walking breaks rather than a 30-60-minute MVPA exercise bout that is clearly beyond the ability of many older adults. The light walking intervention produces a lower blood pressure response that is particularly significant, as increases in hypertension are a hallmark of ageing and contribute to increases in mortality rates. The walking intervention speed was 2.4-4.4km/h, well within the ability of older adults.

4 A group brisk walking programme could produce equally significant changes to an individual supervised medical fitness model over a 12-month period. One major concern was the significant drop-out rate in both interventions. The main reasons given were lack of motivation and lower-body overuse injuries and orthopaedic problems. In diabetic groups, it has been reported that high drop-out rates are mainly due to neuropathies and poor muscle strength and sarcopenia.

5 There is a significant shift away from exercise bouts >10 minutes required to receive any major health benefits and all-cause mortality to <10-minute bouts. This is of particular importance for public health messaging, allowing people to accumulate physical activity of shorter durations in any form over the course of the waking day.

6 The interventions used to limit the transmission of one pandemic has inadvertently led to the development of another pandemic, which may prove to be as costly in both lives and financial costs. Type 2 diabetes accounts for approximately 9% of the NHS budget, with 200,000 people every year being diagnosed with the condition. This number will escalate due to lockdown by over 98,000 new cases. Diabetes can be controlled with diet, medication and physical activity.

7 It seems plausible that, to remedy the metabolic side effects of prolonged sedentary time such as insulin resistance and increased plasma lipids, more intermittent multiple contractions over the course of the day might be required in addition to the MVPA 150-minute recommendations. Intermittent muscle contractions provide the stimulus to activate LPL enzymes that are important to extract triglycerides from the blood into tissues and the GLUT 4 transporter necessary for the removal of excessive blood sugar. A single continuous exercise session appears to be less effective in reigniting the LPL enzyme and Glut 4 transporter.

8 People with metabolic syndrome spend more time in sedentary behaviour, have longer sedentary bouts, spend less time in MVPA and have fewer breaks in their sedentary periods, indicating a strong association between the number of sedentary hours and the increased risk of metabolic disease. This is one of the first studies to show this relationship, as many previous reports have found that physical activity predicts metabolic risk.

9 The physical activity prescription based on national guidelines of 150 minutes of MVPA per week proved successful in reducing inactivity levels and producing positive health results. The many motivational techniques used, including self-determination, provided support throughout the six months and contributed to the significant result. While there was an increase in physical activity levels, the reduction in sedentary times was not as significant. More education could have been provided on the problems of prolonged sitting, as it was limited with the emphasis being on improving activity levels.

10 The use of light-intensity physical activity can cause significant improvements in insulin and glucose metabolism and lowering mortality risk, particularly when MVPA is difficult to sustain long term. Light-intensity physical activity is an important option for some populations, including the elderly, obese, overweight, metabolic syndrome and other chronic conditions that make movement difficult. Reports indicate that the effects of light-intensity physical activity can be stronger in those who are metabolically unhealthy and sedentary. It also has great application in those who struggle with motivation in undertaking an MVPA programme.