Exercise prescription for patients with type 2 diabetes—a synthesis of international recommendations: narrative review

Romeu Mendes,[1,2] Nelson Sousa,[2] António Almeida,[2] Paulo Subtil,[3] Fernando Guedes-Marques,[1] Victor Machado Reis,[2] José Luís Themudo-Barata[4]

[1]Public Health Unit, ACES Douro I—Marão e Douro Norte, Vila Real, Portugal
[2]Research Center in Sports Sciences, Health Sciences and Human Development (CIDESD), University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
[3]Diabetes Unit, Trás-os-Montes e Alto Douro Hospital Centre, Vila Real, Portugal
[4]University of Beira Interior; Cova da Beira Hospital Centre, Covilhã, Portugal

Correspondence to
Dr Romeu Mendes, Unidade de Saúde Pública do ACES Douro I—Marão e Douro Norte, Administração Regional de Saúde do Norte, IP, Rua Miguel Torga, 12 F, Vila Real 5000-524, Portugal; romeuduartemendes@gmail.com

Accepted 1 December 2015
Published Online First 30 December 2015

ABSTRACT

Background Physical activity is a cornerstone of type 2 diabetes treatment and control.

Aim We analysed and synthesised the guidelines and recommendations issued by scientific organisations, regarding exercise prescription for patients with type 2 diabetes.

Method A systematic bibliographic search in Pubmed, Web of Science and Scopus databases was conducted. Clinical guidelines from major international scientific organisations in the field of diabetology, endocrinology, cardiology, public health and sports medicine were also considered. 11 publications were selected.

Results Published guidelines recommend a weekly accumulation of a minimum of 150 min of aerobic exercise at moderate-to-vigorous intensity spread over a minimum of 3 days per week. Resistance exercise for muscle strengthening is also recommended at least 2 days a week. Flexibility exercises may complement other types of exercise. Combining aerobic and resistance exercise within the same exercise session is recommended by most guidelines.

Conclusions Exercise prescription for individuals with type 2 diabetes should include specific information on the type, mode, duration, intensity and weekly frequency. The exercise strategies must be adapted for each individual, based on comorbidities, contraindications and realistic personal goals.

INTRODUCTION

Diabetes affects approximately 382 million people worldwide, accounting for 8.3% of the world's population, and continues to increase in all countries—the number of people with diabetes is predicted to increase by 55% by 2035.[1] Type 2 diabetes accounts for approximately 85–95% of all diabetes cases in the world. There are numerous guidelines for exercise advice in type 2 diabetes.

Guidelines recommend physical activity as a non-pharmacological therapeutic strategy fundamental to treatment and control of type 2 diabetes and related cardiovascular risk. It improves glycaemic control, insulin sensitivity, body composition, blood pressure and lipid profile, and mitigates other cardiovascular risk factors.[2–4]

However, the vast majority of patients with type 2 diabetes do not engage in regular exercise.[5–7] For example, in Portugal, about 60% of these individuals reported not practising any type of exercise.[8]

The low prevalence of exercise practice in this population may be explained by the insufficient awareness about the potential benefits of exercise and the lack of specific knowledge about current recommendations.[9–11] However, it may also be explained by behavioural barriers—a gap between knowledge and action. Although likely critically important, the latter is outside the scope of this paper.

We aimed to analyse and summarise the guidelines and recommendations issued by scientific organisations regarding exercise prescription for patients with type 2 diabetes.

METHODS

Bibliographic research was conducted in Pubmed, Web of Science and Scopus online databases, in December 2014, using the terms physical activity, exercise, type 2 diabetes, prescription, guidelines, recommendations, position and statement (search in title for: ('physical activity' OR exercise) AND 'type 2 diabetes' AND (prescription OR guidelines OR recommendations OR position OR statement)), with no limitation on publication date or language. Only publications issued by scientific organisations regarding the treatment of type 2 diabetes were selected.

Clinical guidelines from major international scientific organisations in the field of diabetology, endocrinology, cardiology, public health and sports medicine, regarding physical activity and exercise in the treatment of type 2 diabetes, were also analysed. The most updated publication was selected within each organisation.

RESULTS

Search in Pubmed, Web of Science and Scopus online databases resulted in locating 43 publications. Only six were subscribed by scientific societies. However, two of these documents were already out of date within the same organisation. A total of four papers were selected.[12–15] From the direct analysis of major international scientific organisations clinical guidelines, seven publications were selected.[2 3 16–20]

Table 1 summarises the 11 selected publications from International Diabetes Federation,[2] European Association for the Study of Diabetes,[3 17] American Diabetes Association,[12 16 17] Francophone Diabetes Society,[20] European Society of Cardiology,[3] American Heart Association,[14] American College of Sports Medicine,[12] Exercise and Sports Science Australia,[15] Belgian Physical Therapy Association,[13] Canadian Diabetes Association[19] and Swedish National Institute of Health.[18]

To cite: Mendes R, Sousa N, Almeida A, *et al*. *Br J Sports Med* 2016;**50**:1379–1381.

Table 1 Guidelines for exercise prescription in patients with type 2 diabetes, issued by several scientific organisations

Organisation	Type	Mode	Duration	Intensity	Frequency
ACSM and ADA[12]	Aerobic	Any form that uses large muscle groups (eg, brisk walking)	Minimum of 150 min/week	Moderate to vigorous	At least 3 days/week with no more than 2 consecutive days without exercising
	Resistance	Resistance machines and free weights involving major muscle groups	1–4 sets 8–15 repetitions 5–10 exercises on each session	Moderate to vigorous	At least twice weekly on non-consecutive days
	Flexibility	Included as part of a physical activity programme; it should not substitute other types of exercise			
FDS[20]	Aerobic		Minimum of 150 min/week	At least moderate	At least 3 days/week with no more than two consecutive days without exercising
	Resistance	Exercises involving major muscle groups	3 sets 8–10 repetitions 5–10 exercises on each session	Moderate to vigorous	At least twice weekly on non-consecutive days
BPTA[13]	Aerobic		Minimum of 150 min/week	Low to moderate	3–5 days/week
	Resistance		3 sets 10–15 repetitions 5–10 exercises on each session	Moderate	Combined with aerobic exercise
ESSA[15]	Aerobic	Large muscle activities (eg, walking, running, cycling and swimming)	Minimum of 150 min/week OR Minimum of 90 min/week	Moderate Vigorous	No more than two consecutive days without exercising
	Resistance	Multi joint exercises involving large muscle groups	2–4 sets 8–10 repetitions 8–10 exercises on each session 60 min/week OR 35 min/week	Moderate Vigorous	Two or more sessions per week
CDA[19]	Aerobic	Large muscle activities (eg, biking, brisk walking and continuous swimming)	Minimum of 150 min/week	Moderate to vigorous	At least 3 days/week with no more than two consecutive days without exercising
	Resistance	Resistance machines or free weights	3 sets 8 repetitions	Moderate to vigorous	At least twice weekly
AHA[14]	Aerobic	Large-muscle activities	Minimum of 150 min/week OR Minimum of 90 min/week	Moderate Vigorous	3–7 days/week 3 days/week
	Resistance	Multi joint exercises; large-muscle groups	2–4 sets 8–10 repetitions Exercises for all muscle groups on each session	Moderate to vigorous	3 days/week
ADA[16]	Aerobic	For example, walking	Minimum of 150 min/week	Moderate	At least 3 days/week with no more than two consecutive days without exercising
	Resistance	Free weights or weight machines involving large muscle groups	At least 1 set 5 or more different exercises on each session		At least twice per week
SNIPH[18]	Aerobic	For example, brisk walking, cycling For example, tennis, swimming	Minimum of 30 min 20–60 min	Moderate Vigorous	Daily 3–5 days/week
	Resistance	Bodyweight, elastic bands, free weights or weight machines	8–12 repetitions of each exercise 8–10 exercises on each session		2–3 days/week
	Flexibility	5–10 min at the end of aerobic and resistance exercise sessions			
IDF[2]	Aerobic Resistance		Minimum of 150 min/week	Moderate	3–5 days/week 3 days/week
ADA and EASD[17]	Aerobic Resistance Flexibility		Minimum of 150 min/week	Moderate	
ESC and EASD[3]	Aerobic Resistance		Minimum of 150 min/week	Moderate to vigorous	

ACSM, American College of Sports Medicine; ADA, American Diabetes Association; AHA, American Heart Association; BPTA, Belgian Physical Therapy Association; CDA, Canadian Diabetes Association; EASD, European Association for the Study of Diabetes; ESC, European Society of Cardiology; ESSA, Exercise and Sports Science Australia; FDS, Francophone Diabetes Society; IDF, International Diabetes Federation; SNIPH, Swedish National Institute of Public Health.

DISCUSSION

The importance of exercise as a cornerstone of diabetes treatment, particularly of type 2 diabetes, is recognised by major international scientific organisations in this field, such as the International Diabetes Federation,[2] the European Association for the Study of Diabetes,[3 17] or the American Diabetes Association.[12 16 17]

Six of the selected documents[12–15 19 20] are specific-exercise guidelines for the treatment of diabetes, four documents[2 3 16 17] are general guidelines for the control of diabetes with specific recommendations for exercise prescription and one document is a publication with guidelines for exercise in the treatment of disease, with specific recommendations on diabetes.[18]

Aerobic exercise recommendations

Published guidelines recommend the accumulation of a weekly minimum of 150 min of aerobic exercise with moderate intensity,[2 3 12–20] an activity that can be conducted while maintaining an uninterrupted conversation (4–6 points in a rate of perceived exertion scale of 0–10 points, 12–13 points in a rate of perceived exertion scale of 6–20 points, 40–59% of heart rate reserve, or 64–76% of the maximum heart rate),[21–23] spread over a minimum of 3 days per week with no more than two consecutive days without exercise.

Alternatively, and if there are no cardiovascular or musculoskeletal contraindications, patients are recommended to accumulate a weekly minimum of 90 min of vigorous-intensity aerobic

exercise,[14 15 18] an activity in which a conversation generally cannot be maintained uninterrupted (7–8 points in a rate of perceived exertion scale of 0–10 points, 14–17 points in a rate of perceived exertion scale of 6–20 points, 60–89% of heart rate reserve, or 77–95% of maximum heart rate).[21–23]

Aerobic exercise can be practiced throughout the day in bouts of at least 10-min duration, and combinations of moderate and vigorous-exercise can be performed to accomplish total recommended aerobic exercise volume. For most patients with type 2 diabetes, brisk walking is a moderate-intensity aerobic exercise and jogging is a vigorous-intensity aerobic exercise.[24]

More benefits can be obtained by engaging in aerobic exercise volumes higher than the recommended amounts, which can be very important in cases of obesity.[12 13 15]

Resistance exercise recommendations

Resistance exercise for muscle strengthening is also recommended in addition to aerobic exercise, despite the exercise dose not being unanimous.[12–16 18–20] The most consensual recommendation seems to be the minimum weekly frequency of exercise—at least twice a week, on non-consecutive days. One to four sets of 5–10 multijoint exercises involving the major muscle groups are recommended per exercise session.

A slow progression of the number of sets and the load used is advisable. Initially, only one set of each exercise should be performed, with a load that allows the completion of 10–15 repetitions (50–69% of one repetition maximum—moderate intensity).[22] After a few months of training, a load that does not allow the completion of more than 8–10 repetitions and that results in local muscle fatigue should be selected (70–84% of one repetition maximum—vigorous intensity).[22]

Combined aerobic and resistance exercise within the same exercise session has a more favourable impact on glycaemic control than aerobic or resistance exercise alone.[3 12 13 15]

Flexibility exercise recommendations

Flexibility exercises are also recommended. They complement other types of exercise and are particularly useful for older people with type 2 diabetes.[12 17 18]

Practical implications

The guidelines of exercise prescription for patients with type 2 diabetes that were analysed in this review do not significantly differ from the exercise recommendations for the general population in the context of public health.[24 25] However, the application from these guidelines should have a slow progression and, initially, patients can benefit from lower exercise volumes and intensities. Over the long term, the duration and weekly frequency of exercise sessions more than exercise type or intensity seem to affect glycaemic control.[26]

Because patients with type 2 diabetes may be exposed to an increased risk of injury and acute adverse events during physical activity, exercise prescription for this population should also include recommendations for the prevention and control of conditions such as diabetic foot, diabetic retinopathy, diabetic nephropathy, diabetic autonomic neuropathy, cardiovascular risk, musculoskeletal disorders, hypoglycaemia, hyperglycaemia, dehydration, and the interactions between pharmacological treatment and exercise.[16 19]

Patients can benefit from a pre-exercise clinical evaluation, proper planning of exercise sessions (such as the slow progression of exercise load, warm-up and cool-down periods and the pauses for hydration) and from supervised exercise by exercise professionals (who can assist with the systematic monitoring of the exercise intensity, foot observation, and regular monitoring of blood glucose and blood pressure levels, before and after exercise).[27] These are important aspects to guarantee the safety of participants and prevent exercise-related injuries and adverse events.

CONCLUSIONS

Scientific organisations recommend the weekly accumulation of a minimum of 150 min of moderate-to-vigorous intensity aerobic activity (walking and/or jogging), spread over a minimum of 3 days a week. Resistance exercise for major muscle groups is also recommended, at least 2 days a week, and in addition to aerobic exercise. Flexibility exercises may also be prescribed, but complementarily to other types of exercise. Exercise prescription should include specific information on the type, mode, duration, intensity and weekly frequency. The exercise strategies must be adapted for each individual, based on comorbidities, contraindications and realistic personal goals.

What are the findings?

- Exercise guidelines agree on a weekly accumulation of a minimum of 150 min of aerobic exercise at moderate-to-vigorous intensity spread over a minimum of 3 days per week. Resistance exercise for muscle strengthening is also recommended at least 2 days a week. Flexibility exercises may complement other types of exercise.
- Individual exercise prescription should include specific information on the type, mode, duration, intensity and weekly frequency.
- Exercise strategies must be adapted for each individual, based on comorbidities, contraindications and realistic personal goals.

Acknowledgements The authors acknowledge the support received from all participants and researchers of the Diabetes em Movimento community-based exercise programme.

Contributors RM and NS planned the study; AA and PS conducted the bibliographic search; RM and NS organised the content; FG-M, VMR and JLT-B reviewed the content; RM submitted the study and is responsible for the overall content.

Funding This work was conducted under Diabetes em Movimento, a clinical trial funded by Portuguese Foundation for Science and Technology (SFRH/BD/47733/2008) and registered in ISRCTN registry (ISRCTN09240628).

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 International Diabetes Federation. *IDF diabetes atlas*. 6th edn. Brussels International Diabetes Federation, 2013.
2 International Diabetes Federation. *Global guideline for type 2 diabetes*. Brussels: International Diabetes Federation, 2012.
3 Ryden L, Grant PJ, Anker SD, *et al*. ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD: the Task Force on diabetes, pre-diabetes, and cardiovascular diseases of the European Society of Cardiology (ESC) and developed in collaboration with the European Association for the Study of Diabetes (EASD). *Eur Heart J* 2013;34:3035–87.
4 Naci H, Ioannidis JP. Comparative effectiveness of exercise and drug interventions on mortality outcomes: metaepidemiological study. *Br J Sports Med* 2015;49:1414–22.
5 Morrato E, Hill J, Wyatt H, *et al*. Physical activity in U.S. adults with diabetes and at risk for developing diabetes, 2003. *Diabetes Care* 2007;30:203–9.

6 Zhao G, Ford ES, Li C, *et al*. Physical activity in U.S. Older adults with diabetes mellitus: prevalence and correlates of meeting physical activity recommendations. *J Am Geriatr Soc* 2011;59:132–7.
7 Hermann G, Herbst A, Schutt M, *et al*. Association of physical activity with glycaemic control and cardiovascular risk profile in 65 666 people with Type 2 diabetes from Germany and Austria. *Diabet Med* 2014;31:905–12.
8 Mendes R, Dias E, Gama A, *et al*. [Exercise practice and habitual physical activity levels in patients with type 2 diabetes: a pilot study in Portugal]. *Rev Port Endocrinol Diabetes Metab* 2013;8:9–15.
9 O'Hagan C, De Vito G, Boreham CA. Exercise prescription in the treatment of type 2 diabetes mellitus: current practices, existing guidelines and future directions. *Sports Med* 2013;43:39–49.
10 Balducci S, Sacchetti M, Haxhi J, *et al*. Physical exercise as therapy for type 2 diabetes mellitus. *Diabetes Metab Res Rev* 2014;30(Suppl 1):13–23.
11 Colberg SR. Physical activity: the forgotten tool for type 2 diabetes management. *Front Endocrinol (Lausanne)* 2012;3:70.
12 Colberg SR, Sigal RJ, Fernhall B, *et al*. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement. *Diabetes Care* 2010;33:e147–67.
13 Hansen D, Peeters S, Zwaenepoel B, *et al*. Exercise assessment and prescription in patients with type 2 diabetes in the private and home care setting: clinical recommendations from AXXON (Belgian Physical Therapy Association). *Phys Ther* 2013;93:597–610.
14 Marwick TH, Hordern MD, Miller T, *et al*. Exercise training for type 2 diabetes mellitus: impact on cardiovascular risk: a scientific statement from the American Heart Association. *Circulation* 2009;119:3244–62.
15 Hordern MD, Dunstan DW, Prins JB, *et al*. Exercise prescription for patients with type 2 diabetes and pre-diabetes: a position statement from Exercise and Sport Science Australia. *J Sci Med Sport* 2012;15:25–31.
16 American Diabetes Association. Standards of medical care in diabetes—2014. *Diabetes Care* 2014;37(Suppl 1):S14–80.
17 Inzucchi SE, Bergenstal RM, Buse JB, *et al*. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care* 2012;35:1364–79.
18 Swedish National Institute of Public Health. *Physical activity in the prevention and treatment of disease*. Stockholm: Swedish National Institute of Public Health, 2010.
19 Sigal RJ, Armstrong MJ, Colby P, *et al*. Canadian Diabetes Association 2013 clinical practice guidelines for the prevention and management of diabetes in Canada: physical activity and diabetes. *Can J Diabetes* 2013;37(Suppl 1):S40–4.
20 Duclos M, Oppert JM, Verges B, *et al*. Physical activity and type 2 diabetes. Recommandations of the SFD (Francophone Diabetes Society) diabetes and physical activity working group. *Diabetes Metab* 2013;39:205–16.
21 Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982;14:377–81.
22 Garber CE, Blissmer B, Deschenes MR, *et al*. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc* 2011;43:1334–59.
23 Norton K, Norton L, Sadgrove D. Position statement on physical activity and exercise intensity terminology. *J Sci Med Sport* 2010;13:496–502.
24 Mendes R, Sousa N, Themudo-Barata JL. [Physical activity and public health: recommendations for exercise prescription]. *Acta Med Port* 2011;24:1025–30.
25 World Health Organization. *Global recommendations on physical activity for health*. Geneva: World Health Organization, 2010.
26 Harmer AR, Elkins MR. Amount and frequency of exercise affect glycaemic control more than exercise mode or intensity. *Br J Sports Med* 2015;49:1012–14.
27 Mendes R, Sousa N, Reis VM, *et al*. Prevention of exercise-related injuries and adverse events in patients with type 2 diabetes. *Postgrad Med J* 2013;89:715–21.