Evidence based exercise: Clinical benefits of high intensity interval training

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Evidence based exercise

Clinical benefits of high intensity interval training

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Background

Aerobic exercise has a marked impact on cardiovascular disease risk. Benefits include improved serum lipid profiles, blood pressure and inflammatory markers as well as reduced risk of stroke, acute coronary syndrome and overall cardiovascular mortality. Most exercise programs prescribed for fat reduction involve continuous, moderate aerobic exercise, as per Australian Heart Foundation clinical guidelines.

Objective

This article describes the benefits of exercise for patients with cardiovascular and metabolic disease and details the numerous benefits of high intensity interval training (HIIT) in particular.

Discussion

Aerobic exercise has numerous benefits for high-risk populations and such benefits, especially weight loss, are amplified with HIIT. High intensity interval training involves repeatedly exercising at a high intensity for 30 seconds to several minutes, separated by 1–5 minutes of recovery (either no or low intensity exercise). HIT is associated with increased patient compliance and improved cardiovascular and metabolic outcomes and is suitable for implementation in both healthy and 'at risk' populations. Importantly, as some types of exercise are contraindicated in certain patient populations and HIIT is a complex concept for those unfamiliar to exercise, some patients may require specific assessment or instruction before commencing a HIIT program.

Keywords

exercise therapy; risk factors; body weight

Obesity rates in Australia are among the highest in the world,[1] with one in 4 adults being obese.[2] Obesity increases the risk of coronary heart disease, type 2 diabetes mellitus (T2DM) and stroke, three of the top five causes of burden of disease and injury in Australia.[2] Dietary modification is the mainstay of any weight loss program[3,4] and has been shown to improve cardiovascular and metabolic risk factors including blood pressure, lipids, serum glucose, glycated haemoglobin (HbA1c) and insulin levels as well as reducing risk of acute coronary syndromes, stroke and all cause mortality.[5–10] Exercise has been shown to be an important additional strategy to a weight loss program.[11] However, in Australia, nearly 40% of males and 60% of females carry out insufficient daily physical activity.[12]

Aerobic exercise has a marked impact on cardiovascular disease risk. Benefits include improved serum lipid profiles, blood pressure and inflammatory markers as well as reduced risk of stroke, acute coronary syndrome and overall cardiovascular mortality.[13–19] Additionally, aerobic exercise is effective in the prevention and management of insulin resistance and T2DM.[20,21]

A recent meta-analysis looking at the effect of different levels of light or moderate physical activity on all cause mortality demonstrated that 30 minutes of moderate exercise five times per week (the basis of most exercise prescription guidelines[22]) reduced all cause mortality by 19% versus no activity.[23] Importantly, as light or moderate aerobic exercise can be carried out in an incidental manner, it is potentially accessible and nondisruptive to most of the population.

High intensity interval training

Many exercise programs prescribed for fat reduction involve continuous, moderate aerobic exercise (CME), as per Australian Heart Foundation clinical guidelines.[22] However, such exercise programs have been shown to fail to result in significant fat loss.[13,24]

High intensity interval training (HIIT) involves repeatedly exercising at a high intensity for 30 seconds to several minutes, separated by 1–5 minutes of recovery (either no or low intensity exercise).[25] The most common HIIT intervention used in studies is the Wingate Protocol developed in the 1970s.[26] This involves 30 seconds of cycling at maximum effort (at an intensity of over 90% of maximal oxygen uptake, also known as 90% of VO_2

max) separated by 4 minutes of recovery, repeated 4–6 times per session, with three sessions per week.[25,27] This results in only 2–3 minutes of exercise at maximum intensity and 15–25 minutes of low intensity exercise per session, making it a time efficient method of exercise. Less demanding protocols may be utilised for sedentary, overweight patients, which is important to remember considering the target patient population for exercise as prevention and management of cardiovascular and metabolic disease.

HIIT vs continuous moderate exercise

High intensity interval training has been shown to significantly reduce subcutaneous fat, especially abdominal fat,[27] as well as total body mass,[28,29] and to improve VO_2 max (a marker of physical fitness)[30] and insulin sensitivity.[31] In comparison with CME, HIIT burns more calories and increases postexercise fat oxidation and energy expenditure more than steady-state exercise.[32] Further, HIIT decreased total cholesterol and LDL-cholesterol, while increasing HDL-cholesterol[33] and VO_2 max[32] more than CME. Interestingly, in a 2008 study, fat loss was significantly increased after HIIT, while fat loss did not change in CME patients versus controls,[31] ie. there was no difference in fat loss between subjects carrying out CME and the inactive subjects. In a study that highlights the efficacy of HIIT, subjects carrying out HIIT demonstrated improvements in endothelial function, VO_2 max, body mass index (BMI), body fat percentage, blood pressure and glucose regulation, more so than a group receiving dietary and psychological advice in addition to CME.[29] Perhaps most importantly, increased exercise energy expenditure (such as with HIIT) as assessed by metabolic equivalents (METs) has been shown to result in a reduced risk of cardiovascular events in both males[18] and females,[17] and decrease all cause mortality.[34] However, long term studies are needed to specifically assess the effect of HIIT on overall mortality.

HIIT effects in high risk populations

In patients with cardiovascular disease, HIIT was shown to be superior to CME in reducing blood pressure,[35] improving endothelial function,[35–37] lipid profiles,[38] VO_2 max,[38] left ventricular[37] and overall myocardial function,[35] as well as reversing left ventricular remodelling in heart failure patients.[37] Patients with metabolic syndrome who carry out HIIT have been demonstrated to have improved endothelial function, insulin signalling, blood glucose and lipogenesis.[29]

Studies carried out in T2DM patients demonstrated reduced blood glucose and increased mitochondrial capacity and GLUT4 expression after only 2 weeks of three 20 minute sessions of HIIT per week,[39] and have been shown to significantly improve glucose tolerance at 6 months with no such changes in CME subjects.[40]

Importantly, HIIT programs are not only effective, but are also safe. HIIT has been used effectively in patients with diabetes,[39] stable angina,[41] heart failure[37] and after myocardial infarct,[38] as well as postcardiac stenting[42] and coronary artery grafting.[43]

Further research is still required into the effect of HIIT versus CME in cohorts with cardiometabolic diseases, especially observation of long term outcomes. Similarly, elucidation of the efficacy of HIIT in certain patient populations is needed, such as in those who have recovered from a cerebrovascular event or in those suffering from peripheral arterial disease.

Patient perspectives

A common reason given for not exercising is time constraints,[44] and long term adherence to exercise programs is often less than 50% at 6 months.[45] HIIT allows equal or improved outcomes for markedly less time investment and has the potential to be associated with higher rates of adherence[46] due to the varied protocol leading to less boredom,[29,47] although this remains controversial.[48] In one study, similar changes were seen over a 6 week period in both HIIT subjects and CME subjects, although HIIT subjects performed only 20% of the exercise duration performed by the CME group,[49] making it an extremely efficient intervention.

Potential disadvantages of HIIT

Injuries are often a concern when beginning any exercise program (particularly one such as HIIT), especially in elderly and sedentary patients. While musculoskeletal injuries may occur, they are not more common in groups performing HIIT[50] versus other forms of exercise and can be minimised with careful selection of exercise equipment, for example cycling instead of walking. A recent systematic review demonstrated no cardiac or other potentially lethal events across seven HIIT studies in patients with coronary artery disease,[51] suggesting HIIT is very safe when performed in a controlled environment, although prescription of such exercise must be considered on an individual patient basis.

Due to the extreme energy expenditure required in the interval phases of HIIT, high levels of motivation are required. While effective in controlled trials, and perhaps associated with higher adherence levels (as discussed above), studies to assess long term adherence rates to HIIT are still needed.

Importantly, as some types of exercise are contraindicated in certain patient populations[52] and because HIIT is a complex concept for those unfamiliar to exercise, some patients may require specific assessment or instruction in HIIT from an exercise physiologist or physiotherapist.

Conclusion

High intensity interval training has been shown to have numerous clinical benefits for both healthy and 'at risk' populations. General practitioners are encouraged to discuss with their patients the concept of 'evidence based exercise' and using HIIT as part of their exercise program.

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References

1. International Obesity Taskforce. Obesity prevalence worldwide. 2010. Available at www.iaso.org/iotf/obesity/ [Accessed 14 August 2012].
2. Australian Institute of Health and Welfare. Australia's health 2010. The Twelfth Biennial Health Report of the Australian Institute of Health and Welfare. Canberra: Australian Government, 2010.
3. Franz MJ, VanWormer JJ, Crain AL, Boucher JL, Histon T, Caplan W, et al. Weight-loss outcomes: a systematic review and meta-analysis of weight-loss clinical trials with a minimum 1-year follow-up. J Am Diet Assoc 2007;107:1755–67.
4. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions

of fat, protein, and carbohydrates. N Engl J Med 2009;360:859–73.
5. Brunner EJ, Rees K, Ward K, Burke M, Thorogood M. Dietary advice for reducing cardiovascular risk. Cochrane Database Syst Rev 2007(4):CD002128.
6. Shai I, Schwarzfuchs D, Henkin Y, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. N Engl J Med. 2008;359:229–41.
7. Dauchet L, Amouyel P, Hercberg S, Dallongeville J. Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. J Nutr 2006;136:2588–93.
8. Wang C, Harris WS, Chung M, et al. n-3 Fatty acids from fish or fish-oil supplements, but not alpha-linolenic acid, benefit cardiovascular disease outcomes in primary- and secondary-prevention studies: a systematic review. Am J Clin Nutr 2006;84:5–17.
9. Dauchet L, Amouyel P, Dallongeville J. Fruit and vegetable consumption and risk of stroke: a meta-analysis of cohort studies. Neurology 2005;65:1193–7.
10. Sofi F, Cesari F, Abbate R, Gensini GF, Casini A. Adherence to Mediterranean diet and health status: meta-analysis. BMJ 2008;337:a1344.
11. Villareal DT, Chode S, Parimi N, et al. Weight loss, exercise, or both and physical function in obese older adults. N Engl J Med 2011;364:1218–29.
12. Egger G, Donovan R, Swinburn B, Giles-Corti B, Bull F. Physical activity guidelines for Australians – scientific background report. A report by the University of Western Australia and The Centre for Health Promotion and Research Sydney. In: Care. Department of Health and Ageing, editor. Canberra, 1999.
13. Johnson NA, Sachinwalla T, Walton DW, et al. Aerobic exercise training reduces hepatic and visceral lipids in obese individuals without weight loss. Hepatology 2009;50:1105–12.
14. Fagard RH, Cornelissen VA. Effect of exercise on blood pressure control in hypertensive patients. Eur J Cardiovasc Prev Rehabil 2007;14:12–7.
15. Swardfager W, Herrmann N, Cornish S, et al. Exercise intervention and inflammatory markers in coronary artery disease: a meta-analysis. Am Heart J 2012;163:666–76 e1–3.
16. Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. Stroke 2003;34:2475–81.
17. Manson JE, Greenland P, LaCroix AZ, et al. Walking compared with vigorous exercise for the prevention of cardiovascular events in women. N Engl J Med 2002;347:716–25.
18. Tanasescu M, Leitzmann MF, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Exercise type and intensity in relation to coronary heart disease in men. JAMA 2002;288:1994–2000.
19. Rossi A, Dikareva A, Bacon SL, Daskalopoulou SS. The impact of physical activity on mortality in patients with high blood pressure: a systematic review. J Hypertens 2012;30:1277–88.
20. Davidson LE, Hudson R, Kilpatrick K, et al. Effects of exercise modality on insulin resistance and functional limitation in older adults: a randomized controlled trial. Arch Intern Med 2009;169:122–31.
21. Cardona-Morrell M, Rychetnik L, Morrell SL, Espinel PT, Bauman A. Reduction of diabetes risk in routine clinical practice: are physical activity and nutrition interventions feasible and are the outcomes from reference trials replicable? A systematic review and meta-analysis. BMC Public Health 2010;10:653.
22. National Vascular Disease Prevention Alliance. Guidelines for the management of absolute cardiovascular disease risk. 2012. Available at http://strokefoundation.com.au/site/media/AbsoluteCVD_GL_webready.pdf.
23. Woodcock J, Franco OH, Orsini N, Roberts I. Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. Int J Epidemiol 2011;40:121–38.
24. Boutcher SH, Dunn SL. Factors that may impede the weight loss response to exercise-based interventions. Obes Rev 2009;10:671–80.
25. Gibala MJ, McGee SL. Metabolic adaptations to short-term high-intensity interval training: a little pain for a lot of gain? Exerc Sport Sci Rev 2008;36:58–63.
26. Bar-Or O, Dotan R, Inbar O. A 30 seconds all out ergometric test: its reliability and validity for anaerobic capacity. Israel Journal of Medical Science 1977;113:226–30.
27. Boutcher SH. High-intensity intermittent exercise and fat loss. J Obes 2011;2011:868305.
28. Perry CG, Heigenhauser GJ, Bonen A, Spriet LL. High-intensity aerobic interval training increases fat and carbohydrate metabolic capacities in human skeletal muscle. Appl Physiol Nutr Metab 2008;33:1112–23.
29. Tjonna AE, Lee SJ, Rognmo O, et al. Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome: a pilot study. Circulation 2008;118:346–54.
30. Helgerud J, Hoydal K, Wang E, et al. Aerobic high-intensity intervals improve VO2max more than moderate training. Med Sci Sports Exerc 2007;39:665–71.
31. Trapp EG, Chisholm DJ, Freund J, Boutcher SH. The effects of high-intensity intermittent exercise training on fat loss and fasting insulin levels of young women. Int J Obes (Lond) 2008;32:684–91.
32. King J, Broeder C, Browder K, Panton L. A comparison of interval vs steady-state exercise on substrate utilization in overweight women. Med Sci Sports Exerc 2002;33:228.
33. O'Donovan G, Owen A, Bird SR, et al. Changes in cardiorespiratory fitness and coronary heart disease risk factors following 24 wk of moderate- or high-intensity exercise of equal energy cost. J Appl Physiol 2005;98:1619–25.
34. Lollgen H, Bockenhoff A, Knapp G. Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories. Int J Sports Med 2009;30:213–24.
35. Molmen-Hansen HE, Stolen T, Tjonna AE, et al. Aerobic interval training reduces blood pressure and improves myocardial function in hypertensive patients. Eur J Prev Cardiol 2012;19:151–60.
36. Guimaraes GV, Ciolac EG, Carvalho VO, D'Avila VM, Bortolotto LA, Bocchi EA. Effects of continuous vs. interval exercise training on blood pressure and arterial stiffness in treated hypertension. Hypertens Res 2010;33:627–32.
37. Wisloff U, Stoylen A, Loennechen JP, et al. Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study. Circulation 2007;115:3086–94.
38. Moholdt T, Aamot IL, Granoien I, et al. Aerobic interval training increases peak oxygen uptake more than usual care exercise training in myocardial infarction patients: a randomized controlled study. Clin Rehabil 2012;26:33–44.
39. Little JP, Gillen JB, Percival ME, et al. Low-volume high-intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes. J Appl Physiol 2011;111:1554–60.
40. Seals DR, Hagberg JM, Hurley BF, Ehsani AA, Holloszy JO. Effects of endurance training on glucose tolerance and plasma lipid levels in older men and women. JAMA 1984;252:645–9.
41. Meyer P, Guiraud T, Gayda M, Juneau M, Bosquet L, Nigam A. High-intensity aerobic interval training in a patient with stable angina pectoris. Am J Phys Med Rehabil 2010;89:83–6.
42. Munk PS, Breland UM, Aukrust P, Ueland T, Kvaloy JT, Larsen AI. High intensity interval training reduces systemic inflammation in post-PCI patients. Eur J Cardiovasc Prev Rehabil 2011;18:850–7.
43. Moholdt TT, Amundsen BH, Rustad LA, et al. Aerobic interval training versus continuous moderate exercise after coronary artery bypass surgery: a randomized study of cardiovascular effects and quality of life. Am Heart J 2009;158:1031–7.
44. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: review and update. Med Sci Sports Exerc 2002;34:1996–2001.
45. Thurston M, Green K. Adherence to exercise in later life: how can exercise on prescription programmes be made more effective? Health Promot Int 2004;19:379–87.
46. King AC, Haskell WL, Young DR, Oka RK, Stefanick ML. Long-term effects of varying intensities and formats of physical activity on participation rates, fitness, and lipoproteins in men and women aged 50 to 65 years. Circulation 1995;91:2596–604.
47. Bartlett JD, Close GL, MacLaren DP, Gregson W, Drust B, Morton JP. High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence. J Sports Sci 2011;29:547–53.
48. Perri MG, Anton SD, Durning PE, et al. Adherence to exercise prescriptions: effects of prescribing moderate versus higher levels of intensity and frequency. Health Psychol 2002;21:452–8.
49. Gibala MJ, Little JP, van Essen M, et al. Short-term sprint interval versus traditional endurance training: similar initial adaptations in human skeletal muscle and exercise performance. J Physiol 2006;575(Pt 3):901–11.
50. Nielsen RO, Buist I, Sorensen H, Lind M, Rasmussen S. Training errors and running related injuries: a systematic review. Int J Sports Phys Ther 2012;7:58–75.
51. Cornish AK, Broadbent S, Cheema BS. Interval training for patients with coronary artery disease: a systematic review. Eur J Appl Physiol 2011;111:579–89.
52. Wise FM. Coronary heart disease: the benefits of exercise. Aust Fam Physician 2010;39:129–33.

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