Descending stair walking as exercise medicine

Lucas Henrique L Araújo [1], Trevor C Chen [2], Kazunori Nosaka [3], Leonardo C R Lima [1]

Over the past several decades, muscle damage represented by delayed-onset muscle soreness and prolonged decreases in muscle function has been a central agenda for exercises mainly consisting of eccentric (lengthening muscle) contractions (ie, eccentric exercises).[1] However, in more recent decades, the paradigm of eccentric exercise has taken on new dimensions with accumulating evidence suggesting its positive effects on health and fitness parameters, especially by low-intensity, moderate-load eccentric exercises.[1] Moderate-load eccentric exercises do not induce as much muscle damage as high-intensity eccentric exercises do, but appear to produce morphological, functional and metabolic adaptations that are important for health and quality of life.[1–3] This editorial will discuss descending stair walking as an inexpensive and easily accessible moderate-load eccentric exercise modality, along with its effects on health, functional capacity and body composition.

MODERATE-LOAD ECCENTRIC EXERCISES

The most abundantly investigated modality of moderate-load eccentric exercise is eccentric cycling,[2 3] in which knee extensor and hip extensor muscles resist against the force generated by backward-moving pedals driven by a motor in a specially designed ergometer or bicycle. Several studies have demonstrated the effectiveness of eccentric cycling in improving body composition and functional capacity.[2 3] In a recent meta-analysis, Barreto *et al*[2] documented that eccentric cycling increases muscle strength and mass, functional capacity and aerobic power, while decreasing body fat. Similarly, eccentric stepping, in which linear instead of circular movements generated by an ergometer are performed, has been shown to improve functional capacity and body composition.[4] However, the cost of the ergometers is a negative aspect of these exercise modalities.[3]

A modality that is inexpensive, accessible and widely implementable in daily exercise routines is 'eccentric walking', including downhill walking,[1] lunge walking[5] and descending stair walking (DSW).[6–12] Although still under-researched, 'eccentric walking' shares similarities with eccentric cycling in its effects, but with negligible costs and greater applicability. The motor actions in 'eccentric walking' involve submaximal-intensity eccentric contractions of the knee and hip extensors that absorb the load imposed by the body mass, and its low-intensity and cyclical characteristics make it possible to perform this activity for prolonged periods.

Descending stair walking exercise

When comparing the physiological responses between self-paced ascending stair walking (ASW) and DSW using 22 flights of stairs, Teh and Aziz[6] reported that average heart rate and oxygen uptake were 49% and 97% smaller for DSW, respectively. They also found that DSW was performed at a moderate-intensity domain, but ASW was performed at a high-intensity domain. The calculated energy cost of ASW and DSW was 0.11 and 0.05 kcal/step, respectively, showing that the energy demand of DSW was 50% lower than that of ASW. The lower energy demand in DSW is likely due to the involvement of non-cross-bridge components in eccentric force generation, such as the elastic protein titin and connective tissues in muscle.[1] This may be disadvantageous for chronic cardiorespiratory adaptations and fat loss for individuals with less physical fitness. Chen *et al*[7] found no significant differences between DSW and ASW for the magnitude of decrease in body mass and fat, but greater decreases in resting heart rate and systolic blood pressure after DSW compared with ASW with both interventions consisting of 2–24 repetitions of 2 min stair walks (one step/s) performed twice per week for 12 weeks by elderly women with obesity. They also showed superior improvements in muscle strength, functional fitness, bone mineral density, insulin sensitivity and blood lipid profile after DSW compared with ASW. Additional data[8] from the same study revealed that a decrease in serum complement component 1q concentration (a biomarker of fibrosis and muscle atrophy associated with sarcopenia) and an increase in plasma concentrations of adropin (a regulator of carbohydrate and lipid metabolism and endothelial function) and apelin (an adipokine involved in cardiovascular function and fluid homeostasis) were greater after DSW compared with ASW.

Chow *et al*[9] also reported that 12 weeks of DSW (3–17 sets of 1.5 min, three times a week) resulted in significantly greater reductions in homeostatic model assessment for insulin resistance, a surrogate measure of insulin resistance, and serum concentration of tumour necrosis factor-α when compared with ASW in women with obesity, but DSW and ASW were equally effective in reducing serum interleukin-6 concentration, body mass, body mass index and total fat mass. Furthermore, Regnersgaard *et al*[10] showed that 6 weeks of unloaded DSW and DSW with a load equivalent to 15% of body mass—both performed until voluntary exhaustion three times a week—resulted in similar improvements in lower-limb muscle mass, strength and power in 32 elderly individuals. Significant improvements in the 6 min walk test and 30 s chair-to-stand were also observed for both conditions similarly. Additionally, Theodorou *et al*[11] showed that 6 weeks of DSW (four sets of 3 min, three times per week) improved knee extensor peak torque in patients with heart failure. This confirmed the efficacy of DSW in improving neuromuscular function and suggested that it can be implemented to a population with low exercise tolerance.

Current knowledge, clinical application and future perspectives

A comprehensive analysis of the above studies leads us to conclude that DSW training is feasible, easily implementable, cost-effective and adequate for various populations including those with chronic diseases. It should be noted that the duration of the exercise programme seems to determine the manifestation of its benefits, as longer-duration studies resulted in more pronounced outcomes.[7 8 10]

[1]School of Physical Education and Sport of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil
[2]Department of Physcial Education and Sport Sciences, National Taiwan Normal University, Taipei, Taiwan
[3]School of Medical and HealthScience, Edith Cowan University, Joondalup, Western Australia, Australia

Correspondence to Dr Leonardo C R Lima; leonardocrlima@usp.br

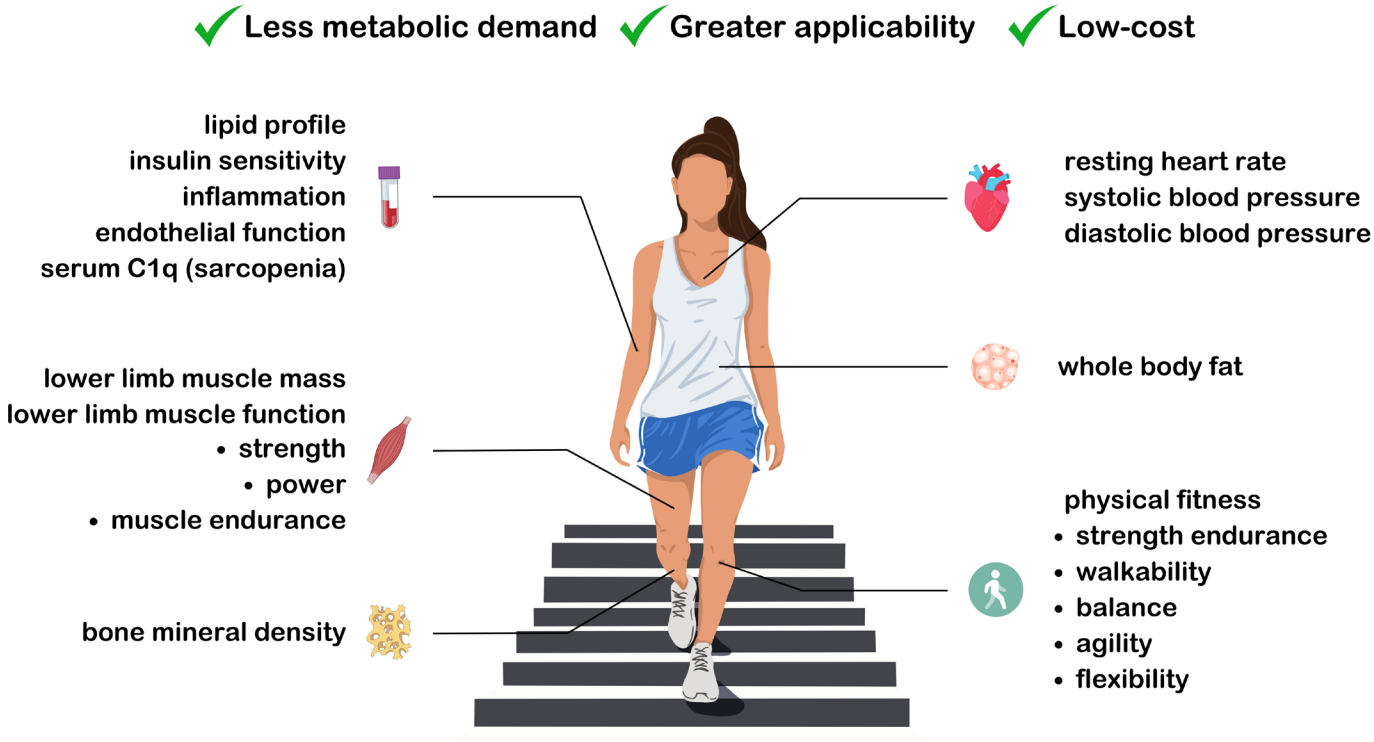

Figure 1 Practical advantages and main health-related benefits of descending stair walking interventions.

It is noteworthy that DSW provides improvements in markers of body composition, cardiovascular function, blood health parameters, lower limb muscle strength and functional performance (figure 1). These are critical for quality of life and especially relevant to those who are not engaged in regular exercise routines. Importantly, the observed improvements are induced by a relatively short period of a lower-intensity and less demanding intervention compared with traditional exercise modalities, thus DSW is ideal as exercise medicine.

Since the literature on DSW is still in its early stages, several gaps remain to be explored, such as the effects of DSW interventions on individuals who are sensitive to acute cardiovascular and respiratory responses to exercise, including patients with peripheral artery disease, heart failure and chronic obstructive pulmonary disease. DSW appears to be particularly relevant for these populations due to its attenuated cardiovascular and respiratory demands. Additionally, it has yet to be determined whether DSW is an effective intervention for the rehabilitation of lower-limb musculoskeletal and joint injuries. The optimal work-to-rest ratios (exercise:rest time; 1:1, 3:1, 5:1, etc) for promoting health benefits through DSW interventions are also unclear. Furthermore, it is important to consider how DSW sessions could be prescribed without muscle damage, overuse injuries, and falls.

When implementing DSW in clinical settings, we recommend that frail patients are closely supervised, whereas supervision may not be required for most other patients. To focus on DSW, strategies for returning to the starting point must be considered, such as using lifts and escalators. When escalators are available, conducting DSW sessions by descending against the upward-moving steps of the escalator should be considered. If passive transportation is not available, climbing stairs at a comfortable pace is another option, although it is time-consuming and energy-consuming. While it is not as cost-effective as the previous options, the use of DSW ergometers[12] should be considered.

Overall, while there are many points that still warrant investigation, DSW appears to be a promising exercise modality that requires little infrastructure, promotes outstanding functional, cardiovascular and metabolic benefits, and can be performed by a wide range of populations including patients with chronic diseases. We would like to see further development of research related to DSW or other types of 'eccentric walking', since these moderate-load eccentric exercises could change exercise medicine prescription.

X Leonardo C R Lima @leonardocrlima

Contributors LA and LL drafted the first version of the manuscript; TC and KN revised the first draft and made substantial improvements to the text; LL drafted the figure; LA, TC and KN revised the figure; LL, TC and KN responded to the reviewers' comments. All authors read and approved the final version of the manuscript. LL is the guarantor of this manuscript.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

To cite Araújo LHL, Chen TC, Nosaka K, *et al*. *Br J Sports Med* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/bjsports-2024-108626

Accepted 21 November 2024

Br J Sports Med 2024;**0**:1–3. doi:10.1136/bjsports-2024-108626

ORCID iDs
Lucas Henrique L Araújo http://orcid.org/0009-0007-8922-173X
Trevor C Chen http://orcid.org/0000-0001-8769-1833
Kazunori Nosaka http://orcid.org/0000-0001-7373-4994
Leonardo C R Lima http://orcid.org/0000-0003-4118-534X

REFERENCES

1 Hoppeler H. Moderate Load Eccentric Exercise; A Distinct Novel Training Modality. *Front Physiol* 2016;7:483.

2 Barreto RV, de Lima LCR, Borszcz FK, *et al*. Chronic Adaptations to Eccentric Cycling Training: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health* 2023;20:2861.
3 Barreto RV, de Lima LCR, Denadai BS. Moving forward with backward pedaling: a review on eccentric cycling. *Eur J Appl Physiol* 2021;121:381–407.
4 LaStayo P, Marcus R, Dibble L, *et al*. Eccentric versus traditional resistance exercise for older adult fallers in the community: a randomized trial within a multi-component fall reduction program. *BMC Geriatr* 2017;17:149.
5 Katsura Y, Takeda N, Inami T, *et al*. Effects of lunges inserted in walking (eccentric walking) on lower limb muscle strength, physical and cognitive function of regular walkers. *Eur J Appl Physiol* 2024;124:2343–52.
6 Teh KC, Aziz AR. Heart rate, oxygen uptake, and energy cost of ascending and descending the stairs. *Med Sci Sports Exerc* 2002;34:695–9.
7 Chen TC, Hsieh C-C, Tseng K-W, *et al*. Effects of Descending Stair Walking on Health and Fitness of Elderly Obese Women. *Med Sci Sports Exerc* 2017;49:1614–22.
8 Chen TC, Huang T-H, Tseng W-C, *et al*. Changes in plasma C1q, apelin and adropin concentrations in older adults after descending and ascending stair walking intervention. *Sci Rep* 2021;11:17644.
9 Chow BC, Li S, Zhu X, *et al*. Effects of descending or ascending stair exercise on body composition, insulin sensitivity, and inflammatory markers in young Chinese women with obesity: A randomized controlled trial. *J Sports Sci* 2021;39:496–502.
10 Regnersgaard S, Knudsen AK, Lindskov FO, *et al*. Down stair walking: A simple method to increase muscle mass and performance in 65+ year healthy people. *Eur J Sport Sci* 2022;22:279–88.
11 Theodorou AA, Panayiotou G, Paschalis V, *et al*. Stair descending exercise increases muscle strength in elderly males with chronic heart failure. *BMC Res Notes* 2013;6:87.
12 Paschalis V, Theodorou AA, Panayiotou G, *et al*. Stair descending exercise using a novel automatic escalator: effects on muscle performance and health-related parameters. *PLoS ONE* 2013;8:e56218.