Wolters Kluwer Health | Lippincott Williams & Wilkins

EUROPEAN SOCIETY OF CARDIOLOGY®

Stair use for cardiovascular disease prevention

Philippe Meyer[a,b], Bengt Kayser[c] and François Mach[b]

[a]Montreal Heart Institute, University of Montreal, Montreal, Canada, [b]Cardiology Service, University Hospital of Geneva and [c]Institute of Movement Sciences and Sports Medicine, University of Geneva, Geneva, Switzerland

European Journal of Cardiovascular Prevention and Rehabilitation 2009, **16 (Suppl 2):**S17–S18

Introduction

There is no doubt that higher physical activity and fitness levels are inversely associated with the risk of cardiovascular disease (CVD) [1]. Yet, most Europeans and Americans do not meet current minimum physical activity recommendations [2] and the prevalence of CVD risk factors related to a sedentary lifestyle, such as obesity and diabetes, is increasing at an alarming rate [3,4]. To counter those trends, there is an urgent need to develop population strategies aiming to increase physical activity. Stair use is inexpensive and can be easily integrated into everyday life by most of the population. Stair climbing represents vigorous-intensity physical activity with oxygen uptake reaching approximately 80% of maximal values in young healthy adults, corresponding up to nearly 10 metabolic equivalents (METs) of energy expenditure [5], sufficient to improve cardiorespiratory fitness [6]. In the Harvard College alumni cohort study, stair climbing was associated with a significant decrease in mortality risk of $\geq 21\%$ for people climbing ≥ 20 floors compared with those climbing less than 20 floors per week [1]. The purpose of this study is to review studies that evaluated the effects of stair use on fitness and CVD risk factors, present results of the recent Geneva Stair study, and finally formulate general conclusions on the promotion of stair use for CVD prevention at a population level.

Does stair use influence fitness and CVD risk?

In 1975, a pioneer nonrandomized study by Fardy and Ilmarinen [7] evaluated the effects of a 12-week stair-climbing program at work in 30 healthy untrained employees (17–64 years) of a Finnish insurance company. VO_{2max} improved by 10% (0.3 l/min) only in the subgroup having climbed 25 floors/day or 125 floors/week ($n = 7$). A subsequent similar 10-week intervention was carried out in sedentary men who climbed 30 floors/day and improved their estimated VO_{2max} by 15% [8]. In a third study including 159 female employees climbing 65 floors/week, a significant impact on estimated VO_{2max} was observed after 24 weeks in the older (mean age 37 years) and less fit (mean VO_{2max} 34 ml/kg/min) subgroups, with improvements of 4.8 and 6.3%, respectively. The limitations of two of these studies were the absence of a significant global effect considering all participants and the fact that outcome measures were restricted to aerobic capacity estimates only.

More than a decade later, Loy *et al.* [9] evaluated the effects of 4 weekly 40-min sessions of stair climbing using an automated stair stepping device during 12 weeks, with or without external load carrying, in 28 sedentary women (50–65 years). Compared with the control group, exercise groups increased their VO_{2max} by, respectively, 11.1% (2.7 ml/kg/min) and 9.6% (2.4 ml/kg/min) as well as their quadriceps muscle strength. This study was also limited by the lack of measurement of other CVD risk factors. In a randomized controlled study, Boreham *et al.* [10] investigated the effect of a 7-week stair-climbing program on cardiorespiratory fitness and lipid profiles in young sedentary women (mean age 20 years). Participants in the stair-climbing group ($n = 12$) performed ascents of a 199 steps public staircase, from 1 ascent/day in the first week to 6 ascents/day in the last 2 weeks. The stair-climbing group had higher HDL cholesterol (+0.24 mmol/l), lower total cholesterol : HDL cholesterol ratio, and decreased (i.e. improved) indices of cardiorespiratory fitness including heart rate, oxygen uptake, and blood lactate during a standardized stair-climbing field test. In the same environment and population, the same author showed a 17% (+4.5 ml/kg/min) increase of VO_{2max} and an approximate 8% (0.17 mmol/l) reduction of LDL cholesterol after 8

Correspondence to Philippe Meyer, MD, Montreal Heart Institute, University of Montreal, 5000 Belanger Street, Montreal, Canada
Tel: +1 514 374 1480; fax: +1 514 374 2445; e-mail: meyer.ph@bluewin.ch
Conflicts of interest: none.

weeks of progressive stair climbing (mean number of climbed floors/week = 142) [11]. The study population, healthy 19-year-old women, limits, however, the extrapolation of these results to the general population. Taken together, these studies would support the contention that stair use may be a simple means for improving cardiorespiratory fitness and other CVD risk factors. However, they are limited by the small numbers of participants involved and by their experimental design differing from normal daily life routine. From a public health perspective, more pragmatic interventions are necessary to evaluate the impact of stair use promotion on the prevention of CVD at a population level.

The Geneva stair study

The rationale of this study was to simulate promotion of stair use at population level by evaluating the potential cardioprotective effects of a worksite promotional campaign of stair use in employees at the University Hospital of Geneva [12]. A selection of healthy volunteers ($n = 77$, mean age 43 years) with an inactive lifestyle, mainly nurses and physicians, were included. Participants were encouraged to use stairs instead of elevators during a 12-week hospital-wide promotional campaign for stair use using positive messages on posters positioned at the 'point-of-choice' between stairs and elevators at each hospital floor. A preintervention and postintervention study design was used because of the risk of contamination of a control group by the promotional campaign. Outcome measures included anthropometrics, blood pressure, physical activity, estimated VO_{2max} and were collected at baseline, 12 weeks, and 6 months (3 months after the end of the intervention). VO_{2max} was estimated by a submaximal step test with extrapolation to the age-predicted maximum heart rate. For 62 of the 69 participants who completed the 12-week intervention, all follow-up testing measurements could be obtained. During 12 weeks, median daily ascended and descended one-story staircase units rose from 5 to 21 ($P < 0.001$) and estimated VO_{2max} increased by 9.2% (3.2 ml/kg/min or 0.22 l/min, $P < 0.001$) corresponding to almost 1 MET. There was a significant decline in waist circumference (1.7%), weight (0.7%), fat mass (1.5%), diastolic blood pressure (1.8%) and LDL cholesterol (3.0%). At 6 months, median daily one-story units had decreased to 7. Benefits on estimated VO_{2max} (+5.9%, $P = 0.001$) and fat mass ($-1.4 \pm 8.4\%$, $P = 0.038$) persisted. The main strengths of this study were the pragmatic design of the intervention and the comprehensive assessment of CVD risk factors. A limitation is the absence of a control group for aforementioned reasons.

Conclusion

Stair use, especially when climbing, is a vigorous physical activity that can be easily implemented in everyday life by most of the population. Several studies suggest that it is effective in improving aerobic capacity and CVD risk factors. For 100–150 climbed floors each week corresponding to 8–12 min of daily exercise, the improvement in aerobic capacity (VO_{2max}) may reach, in previously untrained persons, more than 10%, corresponding to an increase in aerobic capacity of approximately 1 MET. This magnitude of improvement has been associated with a 12–20% reduction of all-cause mortality including CVD in epidemiological studies [1]. Therefore, consistent stair use by most of the population is expected to have a sizeable impact on public health. The question that remains to be answered is how to stimulate stair use by the general population. Information at point-of-choice and changes in architectural design may prove important ways to increase stair use [13–15]. It will take a multidisciplinary approach between health professionals, architects, urban planners, and social scientists to find out what the best ways are to help ourselves and fellow citizens to make simple healthy choices for integrating physical activity in our daily life routine such as choosing the stairs at a point-of-choice.

References

1 Froelicher VF, Myers J. *Effect of Exercise on the Heart and the Prevention of Coronary Heart Disease. Exercise and the heart.* 5th ed. Philadelphia, Pennsylvania: Saunders; 2006. pp. 419–459.
2 Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, *et al.* Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007; **116**:1081–1093.
3 Rosamond W, Flegal K, Furie K, Go A, Greenlund K, Haase N, *et al.* Heart Disease and Stroke Statistics 2008 Update. A Report From the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2007.
4 Morabia A, Costanza MC. The obesity epidemic as harbinger of a metabolic disorder epidemic: trends in overweight, hypercholesterolemia, and diabetes treatment in Geneva, Switzerland, 1993–2003. *Am J Public Health* 2005; **95**:632–635.
5 Teh KC, Aziz AR. Heart rate, oxygen uptake, and energy cost of ascending and descending the stairs. *Med Sci Sports Exerc* 2002; **34**:695–699.
6 American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc* 1998; **30**:975–991.
7 Fardy PS, Ilmarinen J. Evaluating the effects and feasibility of an at work stairclimbing intervention program for men. *Med Sci Sports* 1975; **7**:91–93.
8 Ilmarinen J, Rutenfranz J, Knauth P, Ahrens M, Kylian H, Siuda A, Korallus U. [The effect of an on the job training program – stairclimbing – on the physical working capacity of employees (author's transl)]. *Eur J Appl Physiol Occup Physiol* 1978; **38**:25–40.
9 Loy SF, Conley LM, Sacco ER, Vincent WJ, Holland GJ, Sletten EG, Trueblood PR. Effects of stairclimbing on VO_{2max} and quadriceps strength in middle-aged females. *Med Sci Sports Exerc* 1994; **26**:241–247.
10 Boreham CA, Wallace WF, Nevill A. Training effects of accumulated daily stair-climbing exercise in previously sedentary young women. *Prev Med* 2000; **30**:277–281.
11 Boreham CA, Kennedy RA, Murphy MH, Tully M, Wallace WF, Young I. Training effects of short bouts of stair climbing on cardiorespiratory fitness, blood lipids, and homocysteine in sedentary young women. *Br J Sports Med* 2005; **39**:590–593.
12 Meyer P, Kayser B, Kossowsky M, Sigaud P, Carballo D, Martin XE, *et al.* Stair instead of elevator use at work: cardiovascular preventive effects on healthy employees. The Geneva stair study. *Eur Heart J* 2008; **29** (**Abstract Supplement**):385–386.
13 Webb OJ, Eves FF. Promoting stair climbing: effects of message specificity and validation. *Health Educ Res* 2007; **22**:49–57.
14 Eves FF, Webb OJ, Mutrie N. A workplace intervention to promote stair climbing: greater effects in the overweight. *Obesity (Silver Spring)* 2006; **14**:2210–2216.
15 Nicoll G, Zimring C. Effect of innovative building design on physical activity. *J Public Health Policy* 2009; **30** (**Suppl 1**):S111–S123.