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Original Scientific Paper

Stairs instead of elevators at workplace: cardioprotective effects of a pragmatic intervention

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Background **Population strategies to increase physical activity are an essential part of cardiovascular disease prevention. However, little data exist on lifestyle interventions that are easy to integrate into everyday life such as using stairs instead of elevators at the workplace.**

Design **Pre and postintervention study.**

Methods **A 12-week promotional campaign for stair use consisting in posters and floor stickers at the point of choice between stairs and elevators at each hospital floor was organized in a university hospital building. In 77 selected employees with an inactive lifestyle, physical activity, aerobic fitness, anthropometrics, blood pressure, lipids, insulin sensitivity, and C-reactive protein were assessed at baseline, 12 weeks, and 6 months.**

Results **During the intervention median daily number of ascended and descended one-story staircase units was 20.6/day (14.2–28.1) compared with 4.5/day (1.8–7.2) at baseline ($P<0.001$). At 12 weeks, estimated maximal aerobic capacity had increased by 9.2 ± 15.1% ($P<0.001$) corresponding with approximately 1 MET. There were significant declines in waist circumference (−1.7 ± 2.9%), weight (−0.7 ± 2.6%), fat mass (−1.5 ± 8.4%), diastolic blood pressure (−1.8 ± 8.9%), and low-density lipoprotein cholesterol (−3.0 ± 13.5%). At 6 months, the median daily number of ascended and descended one-story staircase units had decreased to 7.2 (3.5–14.0). Benefits on estimated maximal aerobic capacity (+5.9 ± 12.2%, $P=0.001$) and fat mass (−1.4 ± 8.4%, $P=0.038$) persisted.**

Conclusion **Encouraging stair use at work is effective for improving fitness, body composition, blood pressure, and lipid profile in asymptomatic individuals with an inactive lifestyle and thus may be a simple way to significantly reduce cardiovascular disease risk at the population level. *Eur J Cardiovasc Prev Rehabil* 00:000–000 © 2010 The European Society of Cardiology**

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Introduction

There is no more doubt that higher physical activity and fitness levels are inversely associated with the risk of cardiovascular disease (CVD) and its related mortality [1–4]. Based on this evidence, regular physical activity is universally recognized by medical and public health authorities as an essential part of CVD prevention. However, despite increasing health promotion efforts worldwide [5], most Europeans and Americans do not meet current minimum physical activity recommendations [6–8]. Moreover, the prevalence of several CVD risk factors related to a sedentary lifestyle, such as obesity and diabetes is increasing at an alarming rate not only in western countries [9–11], but also in the developing

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world [12]. To counter those trends, there is an urgent need to develop effective strategies aimed at increasing physical activity at a population level [13].

Stair use is an activity that can be easily integrated into everyday life. Stair climbing represents a vigorous-intensity physical activity that is largely sufficient to improve cardiorespiratory fitness in untrained individuals [14]. Most previous studies reporting the benefits of stair climbing programs on fitness were limited by a restricted assessment of CVD risk factors and by experimental designs, which did not integrate stair use into daily routine [15–20]. Other investigators evaluated the effects of interventions to promote stair use at the workplace but did not assess individual responses to these lifestyle changes [21,22]. The objective of this study was to evaluate the potential cardiovascular preventive impact of a worksite-based promotional campaign of stair use in apparently healthy adults with an inactive lifestyle as a simulation for a wider population intervention.

Methods

Study population

Healthy voluntary employees of the University Hospital of Geneva were recruited. Inclusion criteria were: ≥ 18 years, inactive lifestyle (< 2 h exercise or sport each week and < 10 stories/day stair climbing). Exclusion criteria were: history or symptoms of CVD, osteoarticular or other medical conditions hampering stair climbing, part time employment (< 70%), more than 2 weeks absence during the intervention period, or intention to begin a weight control program. Among 136 employees responding to poster announcements and information conferences, 77 were eligible, of which 69 completed the 12-week intervention. Reasons for drop-out were: osteoarticular conditions ($n = 3$, of which two unrelated to the intervention), lost to follow-up ($n = 3$), change of workplace ($n = 1$), symptomatic arrhythmia during exercise ($n = 1$). Complete follow-up measurements were available for 62 (90%) participants. The protocol was approved by the Research Ethics Committee of the University Hospital of Geneva and each participant gave a written informed consent.

Design and setting

The study was conducted in the main building of the University Hospital of Geneva from February to October 2007. The hospital building is 12 stories tall with several conveniently positioned staircases. Each story has two flights of 10 steps with a height of 15 cm. The intervention consisted of using stairs instead of elevators during normal working hours, for 12 weeks. A hospital-wide promotional campaign for stair use was launched at the beginning of the study using positive messages on posters and floor stickers positioned at the ‘point-of-choice’ between stairs and elevators at each hospital floor and study participants wore badges indicating their participation to the study. No special instructions were given on any desired number of ascended and descended stories on physical activity apart from the intervention or on dietary habits during the study. Participants were assessed at baseline, 12 weeks, and 6 months (i.e. 3 months after the end of the intervention). A pre and postintervention study design was used to avoid the risk of contamination of a control group by the hospital-wide promotional campaign of stair use.

Outcome measures

Following a standardized protocol, all outcome measures were collected by the same trained technicians, with the same material, between 06:30 and 09:30 h after an overnight fast, except for the exercise test (after a light breakfast). All participants were tested within 11 days at each of the three study periods (baseline, 12 weeks, and 6 months).

Physical activity and diet

Physical activity and eating habits were monitored by validated physical activity and food frequency questionnaires that were completed at each of the three visits [23,24]. The number of ascended and descended one-story staircase units was self reported using physical activity diaries printed on the back of the study participation badges. For an objective assessment of physical activity, the participants wore an accelerometer (Actigraph, GT1M, Pensacola, Florida, USA) on the right hip during waking hours for 7 days after every visit. Only periods between 08:00 and 21:00 h were analyzed. Zero activity periods of 20 min or longer were interpreted as being due to unworn accelerometers and were removed from the activity totals. Data were expressed as total activity counts per registered time (counts/min per day) [25].

Fitness level

Maximal aerobic capacity (VO_{2max}) was estimated with the Chester Step Test [26]. This submaximal multistage exercise test consists of stepping on and off a 15–30 cm high step at progressive rates while recording the heart rate. The prediction of VO_{2max} is based on the extrapolation of the line of best fit that passes through the submaximal heart rate responses for each stepping stage, up to a level equal to the participant’s age estimated maximal heart rate. The proper stepping technique was shown by the technicians before each test and then performed by the participants until a regular technique was obtained after which the actual test was performed. Heart rate was measured throughout the test by a wireless heart rate recorder (Smartbelt, PC POD, Suunto, Finland).

Anthropometrics

Body height was measured to the nearest 0.5 cm and body weight to the nearest 0.1 kg on the same calibrated balance beam scale (Seca, Hamburg, Germany) with the participants in light indoor clothing not wearing shoes or heavy sweaters or jackets. One kilogram was deducted for the clothing worn. Waist circumference was assessed with a tape measure at end expiration to the nearest 0.1 cm at a horizontal level midway between the lower rib margin and the iliac crest. Two or three measurements were performed (three if the first two values were >0.5 cm apart) and the two closest values were averaged.

Body composition

Body composition was assessed by bioelectrical impedance analysis. Whole-body resistance and reactance were measured with four surface electrodes placed on the right wrist and ankle. Briefly, an electrical current of 0.8 mA oscillating at 50 KHz was produced by a generator (Nutriguard M, DataInput Gmbh, Darmstadt, Germany) and applied to the electrodes with the participant lying supine for 5 min. Fat mass and fat-free mass were calculated by the previously validated Geneva bioelectrical impedance analysis equation [27].

Blood pressure

Left brachial blood pressure and resting heart rate were measured three times at a 1-min interval with an automatic sphygmomanometer (Omron HEM-907, Kyoto, Japan) after 5 min of quite lying in supine position and the last two readings were averaged.

Blood samples

Resting venous blood samples were obtained by Vacutainer technique from an antecubital vein. Fasting plasma lipids, lipoproteins, and glucose were quantified by routine procedures, as described earlier [28]. Plasma insulin concentrations were analyzed by radioimmunoassay using a human insulin specific kit (Linco, Labodia, Yens, Switzerland). To assess insulin sensitivity, we used the homeostasis model assessment of insulin resistance index (HOMA-IR) defined as: [fasting plasma insulin (mU/l) × fasting plasma glucose (mmol/l)]/22.5. Plasma high sensitivity C-reactive protein was determined by a turbidimetric method using the Synchron CX system test (Beckman Coulter Inc., Brea, California, USA).

Statistical analysis

We used the paired Student's *t*-test or the Wilcoxon signed-rank test to compare intraindividual changes of outcome variables between baseline, 12-week, and 6-month measurements, as appropriate. Results are presented as mean ± SD or median (25–75th percentile). Differences were considered significant at a P value less than 0.05 level. To take into account a possible association of sex on the evolution of the dependent variables, we built linear regression models in which this variable was controlled for. According to the distribution of data, parametric or nonparametric regression (quantile regression) was used.

Results

Baseline characteristics

Participants were 42 women and 35 men, mainly physicians and nurses, with a mean age of 43 ± 9.0 years. Baseline characteristics and outcome parameters are presented in Table 1.

Intervention effect on outcome at 12 weeks (Table 2)

During the intervention, the median number of ascended and descended one-story staircase units was 20.6/day (14.2–28.1) compared with 4.5/day (1.8–7.2) at baseline ($P<0.001$). At 12 weeks, VO_{2max} had increased by 9.2 ± 15.1% ($P<0.001$). Participants had lost 0.7 ± 2.6% of body weight ($P=0.022$), body mass index had decreased by 0.7 ± 2.6% ($P=0.038$), fat mass reduction was −1.5 ± 8.4% ($P=0.035$), and waist circumference had declined by 1.7 ± 2.9% ($P<0.001$). There was a significant decrease of diastolic blood pressure (−1.8 ± 8.9%, $P=0.028$) and a marginal reduction of systolic pressure (−1.3 ± 7.2%, $P=0.075$). LDL cholesterol had decreased by 3.0 ± 13.5% ($P=0.026$). Analyses of the questionnaires did not reveal any significant changes in total physical activity, total energy intake or food quality compared to baseline. The only significant sex difference was a higher relative change in systolic and diastolic blood pressures in women (−2.8 ± 7.4 and −3.9 ± 8.1%) compared with men (0.6 ± 6.7 and 0.7 ± 9.3%), respectively ($P=0.05$ and $P=0.03$).

Residual intervention effect on outcome at 6 months (Table 3)

Three months postintervention the median number of ascended and descended one-story staircase units had declined to 7.2/day (3.5–14.0), still significantly higher compared with baseline values ($P<0.001$). There were persistent changes only in VO_{2max} (5.9 ± 12.2%, $P=0.001$) and fat mass (−1.4 ± 8.4%, $P=0.038$). Compared with baseline, triglycerides and HOMA-IR index were significantly lower by −8.1% (−25.5 to 10.1%) and −17.0%, respectively (−38.5 to 12.0%). VO_{2max} relative change was higher in men (9.8 ± 10.7%) compared with women (2.7 ± 12.6%, $P=0.02$).

Discussion

The key finding of this study is that encouraging healthy adults with an inactive lifestyle to use stairs instead of elevators during their daily work routine significantly improved CVD risk factors and increased cardiorespiratory

Table 1 Baseline characteristics of participants

Variables	Pooled data (n=77)	Women (n=42)	Men (n=35)	P value
Age (years)	42.8 ± 9.0	42.8 ± 9.6	42.7 ± 8.2	0.983
Occupation, n (%)				0.002
Physician	20 (26)	3 (7)	17 (49)	
Nurse	25 (32)	18 (43)	7 (20)	
Technician	11 (14)	6 (14)	5 (14)	
Secretary/administrator	9 (12)	6 (14)	3 (9)	
Laboratory assistant	7 (9)	6 (14)	1 (3)	
Other[a]	5 (6)	3 (7)	2 (6)	
Smoking, n (%)	16 (21)	7 (17)	9 (26)	0.330
Ascended and descended one-story staircase units (n/day)	4.2 (1.0–6.9)	2.7 (0.9–6.8)	4.5 (2.0–7.2)	0.190
Total energy expenditure (kcal/day)	2868 ± 647	2733 ± 654	3065 ± 597	0.063
Accelerometer counts (n/min per day)	427 ± 125	415 ± 123	440 ± 127	0.388
Estimated VO_{2max} (ml/kg per min)	37.3 ± 7.4	35.0 ± 6.9	40.1 ± 7.3	0.003
Estimated VO_{2max} (l/min)	2.8 ± 0.8	2.3 ± 0.5	3.4 ± 0.6	< 0.001
Total energy intake (kcal/day)	1931 ± 652	1994 ± 643	1850 ± 664	0.369
Body weight (kg)	74.5 ± 14.4	66.0 ± 10.4	84.8 ± 11.5	< 0.001
BMI (kg/m^2)	25.7 ± 4.4	24.8 ± 4.6	26.8 ± 4.0	0.052
Waist circumference (cm)	88.1 ± 12.9	81.9 ± 11.6	95.5 ± 10.4	< 0.001
Fat mass (kg)	20.5 ± 7.9	20.9 ± 7.8	20.0 ± 8.2	0.637
Fat free mass (kg)	54.1 ± 11.3	45.1 ± 5.0	64.8 ± 6.4	< 0.001
Systolic BP (mmHg)	121.4 ± 14.4	117.9 ± 14.1	125.6 ± 13.8	0.020
Diastolic BP (mmHg)	75.4 ± 10.2	76.9 ± 10.3	73.5 ± 9.9	0.148
Resting heart rate (beats/min)	68.2 ± 10.3	72.4 ± 8.9	63.2 ± 9.7	< 0.001
Total cholesterol (mmol/l)	5.4 ± 1.0	5.5 ± 1.1	5.4 ± 0.9	0.847
HDL cholesterol (mmol/l)	1.5 ± 0.4	1.6 ± 0.4	1.3 ± 0.3	< 0.001
LDL cholesterol (mmol/l)	3.5 ± 0.9	3.4 ± 0.9	3.6 ± 0.8	0.394
Triglycerides (mmol/l)	1.0 (0.71–1.51)	0.8 (0.6–1.3)	1.2 (0.9–1.7)	0.003
HOMA-IR index[b]	2.4 (1.92–3.09)	2.3 (1.6–2.9)	2.4 (2.2–3.4)	0.066
C-reactive protein (mg/dl)	0.7 (0.37–0.75)	1.0 (0.4–2.3)	0.6 (0.4–2.4)	0.735

Values are presented as mean (± standard deviation), median (25–75th percentile) or number of participants (%); The P value refers to differences between women and men (Student's t-test, χ^2 or Wilcoxon signed-rank test). BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VO_{2max}, maximal aerobic capacity. [a]Physiotherapist, dietitian. [b]Homeostasis model assessment-insulin resistance index (HOMA-IR): [fasting plasma insulin (mU/l) × fasting plasma glucose (mmol/l)]/22.5.

Table 2 Intervention effect on outcome variables at 12 weeks (n=69)

Variables	Absolute change, % (12 weeks – baseline)	Relative change, % (12 weeks at baseline)	P value
Ascended and descended one-story staircase units (n/day)	16.4 (10.3–21.8)	442 (212–769)	< 0.001
Total energy expenditure (kcal/day)	− 18.6 ± 358	0.5 ± 12.1	0.704
Accelerometer counts (n/min per day)	21.3 ± 116.8	10.7 ± 37.9	0.140
Estimated VO_{2max} (ml/kg per min)	3.21 ± 5.31	9.2 ± 15.1	< 0.001
Estimated VO_{2max} (l/min)	0.22 ± 0.39	8.4 ± 14.4	< 0.001
Total energy intake (kcal/day)	− 100 ± 514	− 0.4 ± 34.2	0.112
Body weight (kg)	− 0.55 ± 1.95	− 0.7 ± 2.6	0.022
BMI (kg/m^2)	− 0.18 ± 0.71	− 0.7 ± 2.6	0.038
Waist circumference (cm)	− 1.55 ± 2.65	− 1.7 ± 2.9	< 0.001
Fat mass (kg)	− 0.35 ± 1.35	− 1.5 ± 8.4	0.035
Fat free mass (kg)	− 0.21 ± 1.33	− 0.3 ± 2.5	0.195
Systolic BP (mmHg)	− 1.86 ± 8.52	− 1.3 ± 7.2	0.075
Diastolic BP (mmHg)	− 1.77 ± 6.52	− 1.8 ± 8.9	0.028
Resting heart rate (beats/min)	0.22 ± 8.16	0.8 ± 11.9	0.826
Total cholesterol (mmol/l)	− 0.11 ± 0.53	− 1.3 ± 9.5	0.097
HDL cholesterol (mmol/l)	0.02 ± 0.26	4.4 ± 21.7	0.476
LDL cholesterol (mmol/l)	− 0.13 ± 0.49	− 3.0 ± 13.5	0.026
Triglycerides (mmol/l)	− 0.06 (− 0.32 to 0.26)	− 7.1 (− 28.4 to 27.7)	0.389
HOMA-IR index[a]	− 0.10 (− 0.63 to 0.47)	− 2.6 (− 20.9 to 20.2)	0.517
C-reactive protein (mg/dl)	0.01 (− 0.27 to 0.29)	2.4 (− 33.3 to 59.7)	0.677

Values are presented as mean (± standard deviation) or median (25–75th percentile), The P value refers to intraindividual changes (paired Student's t-test or Wilcoxon signed-rank test). BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VO_{2max}, maximal aerobic capacity. [a]Homeostasis model assessment-insulin resistance index (HOMA-IR): [fasting plasma insulin (mU/l) × fasting plasma glucose (mmol/l)]/22.5.

fitness after 12 weeks. The majority of inhabitants of western countries are not sufficiently physically active, a behaviour which contributes to the increasing prevalence of obesity and diabetes and to CVD burden. Our results suggest that simply using stairs instead of elevators may be an effective strategy to increase physical activity and reduce global CVD risk at the population level.

Table 3 Intervention residual effect on outcome variables at 6 months ($n=62$)

Variables	Absolute change, % (6 months − baseline)	Relative change, % (6 months at baseline)	*P* value
Ascended and descended one-story staircase units (*n*/day)	2.55 (−0.05 to 9.38)	87.9 (−2.4 to 271.4)	<0.001
Total energy expenditure (kcal/day)	−90.6 ± 310	−2.2 ± 10.2	0.049
Accelerometer counts (*n*/min per day)	−14.5 ± 90.7	−0.3 ± 20.2	0.251
Estimated VO_{2max} (ml/kg per min)	2.08 ± 4.51	5.9 ± 12.2	0.001
Estimated VO_{2max} (l/min)	0.14 ± 0.36	5.1 ± 12.9	0.003
Total energy intake (kcal/day)	39.6 ± 542	4.1 ± 31.7	0.570
Body weight (kg)	−0.70 ± 3.09	−0.8 ± 4.1	0.077
BMI (kg/m^2)	−0.25 ± 1.08	−0.8 ± 4.1	0.074
Waist circumference (cm)	−0.06 ± 3.30	0.1 ± 3.8	0.890
Fat mass (kg)	−0.44 ± 1.63	−1.4 ± 8.4	0.038
Fat free mass (kg)	−0.10 ± 1.73	−0.1 ± 3.1	0.645
Systolic BP (mmHg)	0.31 ± 9.67	0.5 ± 8.1	0.804
Diastolic BP (mmHg)	−0.42 ± 7.16	0.02 ± 9.5	0.646
Resting heart rate (beats/min)	−1.05 ± 6.35	−1.2 ± 9.3	0.198
Total cholesterol (mmol/l)	−0.06 ± 0.54	−0.6 ± 9.9	0.422
HDL cholesterol (mmol/l)	−0.01 ± 0.23	1.5 ± 18.1	0.713
LDL cholesterol (mmol/l)	0.00 ± 0.56	0.9 ± 16.9	0.946
Triglycerides (mmol/l)	−0.08 (−0.29 to 0.07)	−8.1 (−25.5 to 10.1)	0.010
HOMA-IR index[a]	−0.40 (−0.92 to 0.27)	−17.0 (−38.5 to 12.0)	0.025
C-reactive protein (mg/dl)	0.00 (−0.56 to 0.33)	1.3 (−48.4 to 52.7)	0.938

Values are presented as mean (± standard deviation) or median (25–75th percentile); The *P* value refers to intra-individual changes (paired Student's *t*-test or Wilcoxon signed-rank test). BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VO_{2max}, maximal aerobic capacity. [a]Homeostasis model assessment-insulin resistance index (HOMA-IR): [fasting plasma insulin (mU/l) × fasting plasma glucose (mmol/l)]/22.5.

Effects on physical activity and cardiorespiratory fitness

During the intervention, participants increased their baseline number of ascended and descended one-story staircase units from 4 to 21/day, or 105/week, which corresponded to approximately 10 min of daily exercise integrated into work time. Earlier studies on stair climbing programs reported number of climbed floors per week ranging from 65 to 150 but most of them used less pragmatic types of interventions that were not implemented into everyday life [15–20]. Even though at first glance one would perhaps consider a mere 10 min of stair climbing negligible, such an amount of physical activity is significant as shown by pooled data from the Harvard College alumni cohort study showing that people climbing ≥ 55 stories per week had a 25% decrease in the risk of mortality compared with those climbing less than 20 stories/week [29]. Surprisingly, the accelerometer data did not show a significant increase in overall daily activity levels. Reasons may be a suboptimal discrimination between walking and stair climbing by the accelerometer and the limited time of recording corresponding to an average of 4 workdays at all three observation periods.

The mean increase in aerobic fitness of approximately 1 MET is comparable with previous findings in stair studies [18]. Boreham *et al.* [15] reported even superior effects with 17% of VO_{2max} improvement corresponding to 1.3 METs in 19-year-old sedentary women climbing a mean of 140 floors/week during 8 weeks. According to epidemiologic studies, these changes are relevant as every 1-MET increase in exercise capacity confers approximately a 15% decrease in all-cause mortality in healthy adults [1,3,30]. These changes would be even more beneficial in the most unfit individuals [13,30,31]. Accounting for the limited time of exercise from the intervention, this improvement may reflect the high intensity nature of stair climbing [14]. An increase in leisure time activities may also have contributed to the findings, although this was not supported by the analysis of physical activity questionnaires which indicated, apart from work-site stair use, unchanged physical activity habits and levels.

Participants had decreased stair use 3 months after the end of the intervention and the overall effects on outcome variables were attenuated. The poor residual effect of the intervention was probably partly because of the unforeseen and unannounced closing of the main central staircase in the hospital for renovation purposes just after the end of the 12-week intervention. This fortuitous ecological effect points to the importance of architectural design and the convenient disposition of stair wells with regard to elevators to help people make healthy choices [32,33].

Effects on body composition and cardiovascular disease risk factors

Study participants lost an average of 550 g of body weight of which 350 g were fat. The 1.5 cm decrease of waist circumference would suggest that a major part of this loss was from abdominal fat. The estimated energy expenditure for the extra ascended and descended one-story staircase units can be calculated as 52 kcal/day corresponding to 3150 kcal for the whole intervention [14]. All other determinants of energy balance remaining constant, this could theoretically explain a 350-g loss of body fat. However, interpreting our results this way would be too simplistic as energy balance is under so many influences involving not just exercise and diet, but also metabolic, sociologic, and psychological factors. Previous similar exercise interventions did not find any impact on weight. This could be related to our very standardized protocol of measurement or to mild changes in eating habits with consecutive reduction of energy intake that were not detected by food frequency questionnaires. A recent intervention study of opposite sign in which previously active participants were instructed to reduce their physical activity levels by taking the elevator instead of the stairs, the car instead of walking or biking and reducing daily step count while maintaining their usual diet, showed an increase in abdominal fat of 7% measured by dual energy X-ray absorptiometry after only 2 weeks, corroborating our findings [34]. Dolan *et al.* [35] advanced that the impact of stair use on population obesity levels will be small because of the limited extra energy expenditure related to increased stair use. Our results complete this contention by making the point that because of the body mass index-independent effect of fitness on all-cause mortality [36] any increase in aerobic fitness from stair use may have great public health significance in spite of a limited effect on weight balance.

Despite the low prevalence of CVD risk factors in our study population, we observed significant improvements of LDL cholesterol at 12 weeks, triglycerides at 6 months, diastolic blood pressure at 12 weeks, and HOMA-IR at 6 months. Boreham *et al.* [16] found a rise in HDL and a decrease in LDL cholesterol [15] after stair climbing programs, whereas effects on blood pressure and insulin sensitivity have not been reported yet in similar interventions [15–20]. The concomitant weight loss and the very standardized protocol of measurement may account for these differences. In contrast, the above cited intervention of opposite sign reported a decrease in insulin sensitivity in participants decreasing their physical activity levels, results that are in support of ours [34].

Study limitations

A limitation of our design is the absence of a control group. Nevertheless, the magnitude of the effects, the concordance of most of the changes, and the reduction of benefits at 6 months (3 months postintervention), paralleling the reduction of stair use support the validity of our results. We may have selected motivated persons and our results do not necessarily apply to the general population. However, our pragmatic study still shows that effective lifestyle physical activity changes are feasible and that clinically relevant physical activity can be integrated into daily work routine. Moreover, the relatively low baseline CVD risk profile of our population may have limited the scope of the benefit of the intervention. Finally, as VO_{2max} was estimated, the interpretation of the increase in aerobic capacity warrants some caution. However, the Chester Step Test has been proved a reliable assessment of aerobic fitness changes in healthy adults on a test–retest basis [37]. Furthermore, this very simple submaximal test has the advantage of being specific to the activity performed by the participants and less prone to learning or motivational bias than a maximal cardiopulmonary exercise test on treadmill or cycloergometer.

Conclusion

This study shows that encouraging healthy adults to use stairs instead of elevators at work is effective in improving cardiorespiratory fitness by approximately 1 MET and in reducing CVD risk factors. These results need to be confirmed in a larger cluster randomized study conducted in various environments and further research must address the questions on how to maintain stair use behavior and its benefits on the long term.

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