

Short Communication

Stair walking is obesity-associated: Rate of ascending and descending the stairs at an underground train station in Munich, Germany

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Abstract

Daily stair walking is a time-efficient everyday activity that improves cardiorespiratory fitness, muscle strength, body composition, blood pressure, lipid profiles, and is associated with a reduction in all-cause mortality. However, more than one in three adult Europeans is physically inactive in their everyday life and the exemplary current rate of stair walking in Germany is not known. Therefore, 2,521 people were monitored climbing the stairs or using a parallel escalator over a period of one week in an underground train station in Munich, Germany (January 3rd to 9th, 2022). 53.4% were women and 46.6% men, 30.7% (N = 774) were classified as obviously overweight-obese. 9.1% (N = 229) of all people counted used the ascending stairs - these were slightly more male than female and a total of 19 persons who were obviously overweight-obese. On two observation days, the pedestrians' mode of descent (stairs/escalator) was also recorded on 457 people, of whom 28% (N = 128) were categorized as obviously overweight-obese. With an equal gender distribution, 27.8% (N = 127) of the people counted used the descending stairs, including 22 obviously overweight-obese people. A very small proportion of adults used the stairs in our exemplary sample (every eleventh chose the stairs for ascent and every fourth chose the stairs for descent), which confirms the high development potential for promoting short repetitive bouts of non-exercise physical activity in everyday life - also for overweight-obese people. Internalize the mantra: Stairs are good friends and not enemies!

Key Words: Escalator, Stair climbing, Physical activity, Pedestrian behavior, Mortality

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Introduction

With today more than 60% mainly sedentary jobs and 80% light jobs in most industrialized countries, our automated and mechanized society has largely delegated physical activities to machines, after all, convenience is obligatory! However, since appropriate and regular physical muscle activity exerts a complex and adaptive influence on the entire organism, the exercise-induced adaptations are essential for the functional reliability, safety, capacity and economy of the human biosystem. Banning the strain on the skeletal muscles (40% of the total body mass) from everyday life initially causes muscular and functional deficits, which then also affect the psychological well-being and the overall state of health (Pišot, 2021).

Stair climbing is one of the most physiologically vigorous everyday activity, is seven times more strenuous than running on the flat and requires 9.6 times the energy expenditure of the resting state. Climbing the stairs burns about 10 kcal per minute (Teh & Aziz, 2002). Accumulating short bouts of stair walking activity throughout the day has been shown to improve cardiorespiratory fitness, vascular endothelial function (flow-mediated and nitroglycerine-induced vasodilation), leg strength, body composition (weight, waist circumference, fat mass), blood pressure, lipid profiles, fasting blood glucose, postprandial insulin and non-esterified fatty acids levels, as well as dynamic balance and cognitive performance (Allison et al., 2017; Boreham et al., 2000; Chen et al., 2021; Cho et al., 2020; Chow et al., 2021; Donath et al., 2014; Dunford et al., 2021; Jenkins et al., 2019; Meyer et al., 2010; Michael et al., 2021; Rafiei et al., 2021; Stenling et al., 2019; Wong et al., 2018; Yamaji et al., 2021). Due to the diverse metabolism-activating benefits, daily stair climbers could probably also be better protected against metabolic syndrome (Whittaker et al., 2021). On a longer-term basis, walking more than five floors of stairs per day is associated with a reduction in all-cause and cancer mortality (Rey-Lopez et al., 2019; Sanchez-Lastra et al., 2021). There is much to suggest that using the escalator is a permanent habit and therefore an automated action (Eves & Puig-Ribera, 2019).

Health agencies all over the world encourage the daily accumulation of lifestyle activities, such as stair walking: "Use stairs whenever you can instead of the lift or escalator" (Gates & Murray, 2017). However, more than one in three adult Europeans is physically inactive in their everyday life (Nikitara et al., 2021) and the exemplary current rate of stair walking in Germany is not known. The aim of this investigation was therefore to determine the current prevalence of adult pedestrians using escalators or adjacent stairs for ascent or descent in an underground train station in Munich, Germany.

Materials and Methods

With the help of a paper-and-pencil counting protocol, the adults climbing or driving at an underground train station exit with 26 steps from a parallel escalator to the stairs were monitored throughout one week (Westfriedhof underground train station, Moosach district, Munich, Germany) (Figure 1). For the observations of the pedestrians' mode of ascent (stairs/escalator) from January 3rd to 9th, 2022, seven counting dates of two hours each on different days and times of the week were selected (Monday, Wednesday, and Friday from 11 a.m. to 1 p.m. and Tuesday, Thursday, Saturday, and Sunday from 4.30 p.m. to 6.30 p.m.). On the last two counting days, the pedestrians' mode of descent (stairs/escalator) was also recorded - the free choice to use the escalator was required at the time of arrival. Concerning the count, gender was considered to determine whether there were any sex-specific differences. Obvious overweight was also inconspicuously noted by the investigators based on the body silhouettes of the passersby. The validated body mass index (BMI)-assigned Stunkard Scale was used as a practical easy visual tool to categorize people with overweight and obesity. The original Stunkard's figure rating scale has been developed and widely validated as a measure of body size in different populations. Stunkard silhouettes contained 9 male and 9 female figures that increase slowly in size from very thin to very obese and we used for our observation setting the body figure number 6 as the starting point for overweight status (men: 28.52 kg/cm²; women: 28.75 kg/cm²) (Stunkard et al., 1983; Parzer et al., 2021).

Children and people with walking aids, prams, or people who were visibly carrying heavy luggage or two or more bags, as well as pedestrians who also walked briskly on the escalator were excluded from the observation. Data collected was analyzed by using descriptive statistics in percentage with Microsoft Excel.

Results

Table 1 present the absolute adult pedestrians' numbers and numbers in percentages for ascending stair and escalator use, for the seven counts that were done. During the study period, a

total of 2,521 people was monitored going up the stairs or using the escalator. Of the population observed, 53.4% were women and 46.6% men, 30.7% (N = 774) were classified as obviously overweight-obese. 9.1% (N = 229) of all people counted used the ascending stairs - these were slightly more male than female (N = 142 versus 87) and a total of 19 persons who were overweight (9 female and 10 male). The remaining passersby used the escalator.

Table 2 present the absolute adult pedestrians' numbers and numbers in percentages for descending stair and escalator use. During the last two counting days, a total of 457 people was monitored going down the stairs or using the parallel escalator. With equal gender distribution, 28% (N = 128) were categorized as obviously overweight-obese. 27.8% (N = 127) of all people counted used the descending stairs - these were slightly more male than female (N = 73 versus 54) and a total of 22 persons who were overweight-obese (9 female and 13 male). The remaining passersby used the escalator.

Table 1. Rate of stair climbing at a Munich underground station (January 3rd to 9th, 2022), stratified by condition and gender.

| | Total N (%) | Females N (%) | Males N (%) | Obvious overweight- obese N (%) |
|-----------------------------|------------------|------------------|------------------|--|
| Total | 2,521 (100%) | 1,347 (53.4%) | 1,174 (46.6%) | 774 (30.7%) |
| Use of stairs | 229 (9.1%) | 87 (6.5%) | 142 (12.1%) | 19 (2.5%) |
| Use of escalator | 2,292 (90.9%) | 1,260 (93.5%) | 1,032 (87.9%) | 755 (97.5%) |

Table 2. Rate of stair descending at a Munich underground station (January 8rd to 9th, 2022), stratified by condition and gender.

| | Total N (%) | Females N (%) | Males N (%) | Obvious overweight- obese N (%) |
|-----------------------------|----------------|------------------|----------------|--|
| Total | 457 (100%) | 222 (48.6%) | 235 (51.4%) | 128 (28.0%) |
| Use of stairs | 127 (27.8%) | 54 (24.3%) | 73 (31.1%) | 22 (17.2%) |
| Use of escalator | 330 (72.2%) | 168 (75.7%) | 162 (68.9%) | 106 (82.8%) |



Figure 1. Underground train station exit with a 26 steps staircase and a parallel escalator (Westfriedhof, Moosach district) in Munich, Germany

Discussion

The present results show very low use of stairs within the monitored period and thus reflect the generally prevailing comfort in everyday behavior - only every eleventh chose the stairs for ascent and every fourth chose the stairs for descent at the observed underground train station in Munich. To our knowledge, this is the first monitoring of the rate of stair walking in southern Germany.

In a first older pilot study, Müller-Riemenschneider et al. observed a percentage rate of stair climbing of 23.6% at three underground stations in Berlin, Germany (Müller-Riemenschneider et al., 2010). However, this is in contrast to numerous other investigations of pedestrians' behavior in travel contexts, which found a stair avoidance of over 90% (Bauman et al., 2017; Eves, 2014). Baumann and colleagues evaluated 50 stair-promoting studies for their meta-analysis and determined a stair use rate of 8.1% (Bauman et al., 2017). Our currently observed rate of stair climbing of 9.1% in a Munich underground train station confirms these data at the same level and shows that stair use behavior has not changed in recent years. The development potential for promoting short repetitive bouts of non-exercise physical activity in everyday life is still very high and desirable (non-exercise activ-

-ity thermogenesis). Earlier studies repeatedly showed that stair walking interventions (e.g., posters and stairwell encouraging messages to use the stairs, footprints, adding artwork, playing music, environmental attractive stairwell enhancements, etc.) in public settings and worksites successfully change human behavior (Jennings et al., 2017; Moloughney et al., 2018).

According to the studies by other research groups, gender differences could be identified in the present observation (Eves, 2014; Eves, 2020). A few more women than men chose the escalator to climb. In the present observational study, people who appeared to be of normal weight had a higher chance of climbing the stairs than people who were overweight-obese. Only 2.5% of the 774 overweight-obese people counted climbed the stairs. This is in line with previous research by Eves, who also evaluated that overweight pedestrians were significantly more likely to avoid stairs and use the escalators than their comparison groups (Eves, 2014; Eves, 2020). That means the amount of fat-free mass is associated with the level of stair climbing performance, as documented in previous studies on obese people (Sartorio et al., 2004; Choi et al., 2016). A quarter of adults in Germany are obese, which suggests that obese people, in particular, were classified as obviously overweight-obese in the present observational study.

With 27.8% more people choosing the descending stairs - our sample analysis confirmed that stair descent is more common than stair ascent, which is consistent with previous studies and also applies to overweight-obese people (Eves et al., 2006; Kerr et al., 2001). Stair descending exercise also appears more easily followed by the elderly and individuals suffering from disease states (Chen et al., 2017; Theodorou et al., 2013).

Recent studies showed that regular stair climbing can also significantly reduce levels of inflammatory factors such as tumor necrosis factor- α and interleukin-6 in overweight-obese participants (Cabral-Santos et al., 2021; Chow et al., 2021). A 12-week stair walking intervention twice a week in a gradually progressive manner in older obese women resulted in a decrease in plasma complement component 1q and an increase in apelin and a drop in concentrations. Interestingly, the changes were only significant in the descending stair walking group (DSW) and not in the ascending group (ASW) (Chen et al., 2021). Responsible for the different changes could be the performed type of muscle contraction by the knee extensors: mainly eccentric contractions during DSW with greater mechanical stresses on muscle fibers, connective tissue, and blood vessels versus concentric contractions during ASW (Chen et al., 2017; Chen et al., 2021). Additional stair walking studies are needed to evaluate the effects of eccentric and concentric contractions on the expression of myokines and neuropeptides (Chen et al., 2021). Due to osteoarthritis of the knee, for example, the author has been walking backward down every descending stair for several years, which would be interesting to investigate as a more effective stair walking method for the secretion of exercises such as apelin. DSW may be more effective than ASW in improving knee extensor muscle strength, functional physical fitness, bone mineral density, insulin sensitivity, and lipid profiles especially in obese individuals (Chen et al., 2017; Chow et al., 2021).

Stairs are an easy way to incorporate more physical activity into someone's daily routine. In contrast to ascending, descending stairs with the strong eccentric component are perceived as a moderate-intensive based activity and could be more easily integrated into everyday life also at the beginning (Theodorou et al., 2013). However, it is hardly known that the period of consciously executing lifestyle change takes an average of eight weeks before it becomes an automated habit (Hofmeister, 2017). Most activity-motivated people don't make it to that eight-week mark because they change too much too fast in their physical activity at the beginning. Permanent implementation in everyday life needs to start with small, incremental lifestyle changes! It is therefore essential for all those who want to move more to internalize the mantra (Hofmeister, 2017): 'I want and can implement walking three floors per day in everyday life for eight weeks. And I know why I do it.' After just one week, those affected feel more health advantages than disadvantages from the 1-2 mi-

-nute additional muscle activation. After the eight weeks, it can and should be increased by a further two to three floors per day (again for two months for permanent implementation in everyday life).

There are limitations to consider when interpreting our results. One of the limitations of the observational sample that should be noted is the relatively small extent of the information that was collected. Information regarding the age of the pedestrians and recording the number of children would have been of interest. External factors and regional characteristics may have influenced the observed results. Monitoring of suitable underground stations in socioeconomic diverse regions and federal states would be of great interest. A further limitation is the lower number of test subjects for descending stair walking compared to the ascending group that was observed.

Conclusion

In summary, our observed adult rate of stair climbing of 9.1% and stair descending of 27.8% in a Munich underground train station confirms the great development potential for promoting short repetitive bouts of non-exercise physical activity in everyday life - also for overweight-obese people. Active promotion of physical activity begins in the immediate living, leisure, or work environment. Therefore, daily recurring everyday stress such as descending (eccentric-biased) and ascending (concentric-biased) stair walking should be understood by those affected as an excellent time-efficient training stimulus and less as tedious mechanical stress according to the motto "Stairs are very good friends and not enemies".

What is already known on this subject?

Physical inactivity is widespread, so spontaneous everyday habits such as stair walking have an additional health significance.

What this study adds?

The current rate of ascending and descending stair walking is still very low and confirms the high development potential for promoting short repetitive bouts of non-exercise physical activity in everyday life.

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Compliance with ethical standards

Conflict of interest The author declare that he doesn't have any conflict of interest.

Ethical approval All procedures for the observational study were approved by the Ethics Advisory Board of the Consumer Center of the German Federal State of Bavaria and were conducted following the 1975 Declaration of Helsinki.

Informed consent Not applicable.

Author contributions

Conceptualization: M.H.; Methodology: M.H.; Software: M.H.; Validation: M.H.; Formal analysis: M.H.; Investigation: M.H.; Resources: M.H.; Data curation: M.H.; Writing - original draft: M.H.; Writing - review & editing: M.H.; Visualization: M.H.; Supervision: M.H.; Project administration: M.H.; Funding acquisition: M.H.

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