Prompts to increase physical activity at points-of-choice between stairs and escalators: what about escalator climbers?

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Abstract

Since 1980, many studies have evaluated whether stair-use prompts increased physical activity by quantifying changes in stair use. To more completely evaluate changes in physical activity, this study addressed the often-overlooked assessment of climbing up escalators by evaluating the degree to which stair-use sign prompts increased active ascent—defined as stair use or escalator climbing. Over 5 months, at an airport stairs/escalator point of choice, we video-recorded passersby ($N = 13,544$) who ascended either stairs or escalators, on 10 days with signs and 10 days without signs. Ascenders using the stairs, standing on the escalator, and climbing the escalator were compared on days with versus without signs using multivariable logistic regression. The percentage of ascenders on days with versus without signs were as follows: stair use, 6.9 versus 3.6 percent; escalator standing, 75.2 versus 76.0 percent; and escalator climbing, 18.5 versus 20.4 percent. Signs more than doubled the odds of stair use (vs. escalator use; OR = 2.25; 95% CI = 1.90–2.68; $p < .001$). Signs decreased the odds of escalator climbing (vs. escalator standing or stair use); OR = 0.90; 95% CI = 0.82–0.99; $p = .028$). Signs increased the odds of active ascent versus escalator standing by 15 percent (OR = 1.15; 95% CI = 1.05–1.25; $p = .002$). Although stair-use prompts increased stair use more than two-fold (125%), they increased active ascent by only 15 percent, partly because escalator climbing—a behavior not targeted by the intervention—decreased. Although our results corroborated the established consensus that point-of-choice prompts increase stair use, future studies should test interventions designed to increase active ascent.

Keywords

Stairs, Escalator, Active ascent, Physical activity, Point-of-choice prompts, Built environment

INTRODUCTION

Since 1980, investigators have evaluated the effects of stair-use prompts on increasing physical activity by encouraging pedestrians to use stairs [1]. Two articles published in 2010 systematically reviewed the findings from trials using point-of-choice prompt interventions to increase stair use [2, 3]. The most recent review included 60 stair-use interventions [4], the majority of which employed point-of-choice prompts, and found that such interventions were effective in increasing stair climbing in public

Implications

Practice: Focusing interventions only on stair use overlooks escalator climbing, which is likely to have health consequences similar to those of stair use when compared with standing on escalators.

Policy: Since the effects of stair-use interventions on physical activity may be different from those previously reported depending on how escalator climbing changes in response to the intervention, programs using point-of-choice prompts should consider prompts specifically designed to increase both stair use and escalator climbing.

Research: To increase physical activity at points of choice between stairs and escalators, future research is needed to identify effective strategies that can increase both stair use and escalator climbing.

settings. Collectively, the reviewed studies provide convincing evidence that point-of-choice prompts effectively promote the use of stairs, especially in settings where escalators are the alternative method of ascent.

One point-of-choice prompt intervention examined the effects of stair use prompts on changes in both stair use and walking up escalators. In that study, Andersen et al. observed stair and escalator use at the lobby of the convention center used for the American College of Sports Medicine annual meeting in 2001 [5]. Using an analytical model adjusted for age, sex, race, and time of day, the authors found that a point-of-choice prompt (“Be a role model. . . Use the stairs!”) increased both stair use and escalator climbing. This finding suggested that escalator climbing, a behavior not targeted by prompts, might be worthy of assessment.

Point-of-choice prompt interventions are recommended in the Centers for Disease Control and

Prevention's (CDCs) Community Guide [6] as evidence-based tools for increasing physical activity, but to date have focused almost-entirely on stair use and not active ascent—defined as stair use or escalator climbing. This study evaluated the extent to which our stair-use intervention changed active ascent by distinguishing ascenders who merely stood and rode up the escalator from those who ascended actively, either by using the stairs or by climbing the escalator.

METHODS

Sample

The sample consisted of all passersby who ascended the stairs or escalators to the Terminal 1 sky bridge at the San Diego International Airport. All persons were eligible for participation, including airport patrons, airline and airport security and staff, and children. Using a hidden camera, we video recorded 13,544 ascenders over 20 nonconsecutive days—10 days with signs and 10 days without signs—during January to May 2006. The study was conducted between 12:00 pm and 3:30 pm. According to airport authorities, that was the most heavily trafficked time of day at the San Diego International Airport. Days for conducting the study were selected largely to accommodate schedules of student research personnel. Video recording occurred only during the hours of observational data collection. The San Diego State University Institutional Review Board and airport authorities approved all study procedures.

Design

The setting was an outdoor staircase/escalator ascending from the parking lot to the sky bridge, a location providing a clear point of choice between escalators and an adjacent staircase in a high traffic area. The staircase consisted of 34 steps, with a small landing at the midway point, ascending 18.7 vertical feet to the sky bridge. From the first to last step, ascent by escalator standing took 28 s. We camouflaged the camera by placing it on a luggage cart at some distance from the base of the stairs/escalator and covering it with a coat and bags.

To investigate the effect of exposure versus nonexposure to sign prompts on stair and escalator ascent, we used a quasi-experimental design, systematically introducing and removing the exposure of interest—signs bearing one of the five messages prompting stair use.

Intervention

On A-1 size (84 × 60 cm) poster board, determined to be the most effective size for poster prompts [7], five different prompts were printed: “Please reserve the Escalator for those who need it”; “Don't Lose Time, Lose Weight, Use the Stairs”; “Don't waste Time, Trim your Waistline, Use the Stairs”; “You'll

get more Stares if you Use the Stairs”; and “If you want to feel younger, Act Younger, Step it Up! Use the stairs.”

On intervention days, one of the five messages prompting stair use was exhibited on eye-level easels in four strategic locations around the staircase/escalators, to make signs clearly visible to people approaching from any direction. Two signs were placed some distance from the stairs/escalator, facing the parking lot at different angles; a third sign some distance away, facing the bus/taxi passenger drop-off area opposite the parking lot; and a fourth sign near the bottom of the stairs/escalators.

Measures

Research assistants (RAs) reviewed the videos for a number of factors hypothesized to influence stair use. They coded each factor using operational definitions developed in a previously published study (Fig. 1) [8]. Coders were not blind to conditions, as the camera's field of view included the signs posted at the base of the stairs/escalator. Data were coded by two or more RAs for a subset of participants, and 10 percent of the overall sample was used to compute interrater reliability. Cohen's kappa coefficients (κ) were as follows: age, $\kappa = .53$; gender, $\kappa = .93$; ethnicity, $\kappa = .46$; body shape, $\kappa = .33$; shoes, $\kappa = .39$; luggage, $\kappa = .84$; number of bags, $\kappa = .70$; and speed, $\kappa = .81$. Data were double entered in databases by two independent data entry personnel and discrepancies were adjudicated by a third RA.

Pedestrian traffic volume was measured based on the time at which each participant first stepped onto the stairs or escalator [9]. For each minute during a video-recording period, a count of participants whose time stamp occurred within that interval was computed. We then divided traffic volume (participants/minute) into tertiles: low (0–5), medium (6–8), and high (>8). Mean(*SD*) for tertiles are, respectively, as follows: 3.55(1.24), 6.98(0.82), and 11.43(2.73).

Outcome and exposure variables

Of particular interest for this study, RAs coded whether participants walked, ran, or stood on the escalator and there was excellent interrater reliability for this measure ($\kappa = .81$). Escalator ascenders that walked or ran up at least half the length of the escalator were categorized as escalator climbers; otherwise, they were categorized as escalator standers.

Our main exposure variable was sign prompts, coded “1” on days when signs were present and “0” on days when signs were absent.

Analysis

Logistic regression was used to estimate the effect of signs on the following: (a) stair use (coded “1”) versus escalator use (coded “0”); (b) climbing the escalator (coded “1”) versus standing on the escalator or using

Participant: to be counted as a participant, an individual has to be taller than the handrail on the stairs or escalator.

Time: mark at the moment participant steps onto the stairs or escalator.

Age: 1) youth (the participant's elbows are at or below the level of the handrail on the stairs or escalator); 2) adult (the participant's elbows are above the level of the handrail on the stairs or escalator); 3) senior (an adult participant having visible gray hair, or two or more of these characteristics: wrinkles, balding, slouched posture, slow shuffle pace)

Sex: 1) male; 2) female; 3) cannot be determined

Speed: 1) Standing only (participant merely rides up the escalator); 2) walk (participant walks up the escalator at a slow or average pace); 3) rapid (participant walks up the escalator with a brisk or rapid movement; considered walking quick, i.e. power-walking or running)

Body Shape: 1) normal (slim or having a belly that does not stick out further than the rest of his/her body); 1) overweight (having a round shape or a visible belly)

Ethnicity: 1) Caucasian/white; 2) African-American; 3) Other (does not fit into category 1 or 2, e.g., Middle Eastern, Hispanic, Indian, Asian)

Shoes: 1) sport (tennis shoe or sneaker, distinctly athletic); 2) low heel (other footwear such as support or work shoes; if color or markings do not distinguish the footwear as sport shoes, code as low heel); 3) high heel (having a distinct heel with a visible space between the heel and sole of the shoe)

Luggage: 1) low (carrying nothing or carrying only a purse of any size); 2) medium (carrying one object larger than a purse or carrying two or more purse-size or larger objects; a laptop or a briefcase is considered luggage; a small child (i.e., smaller than the handrail on the stairs/escalator) in close proximity to the participant is considered luggage); 3) high (participant has both luggage and children)

Number of bags: continuous variable counting the number of items larger than a purse the participant is observed to be carrying; a laptop or a briefcase is considered a bag; children are not to be counted.

Clothes: 1) informal (at least one of the following: jeans, shorts, denim, T-shirt, untucked shirt, sweatshirt, khakis, ball cap, short sleeve shirt); 2) formal (at least one of the following: suit, tie, sports coat, dress, dress slacks, skirt, collared or buttoned shirt)

Escalator Need: Participants are coded as 1 (yes) if they should take the escalator. This would be any participant with the following characteristics: severely obese (over 300 lbs.) or with visible disability (walking with crutches, cast) or pregnant. Participants are coded as "escalator need" if they are transporting an unusually large object such as a stroller. All others are participants for whom the escalator is not needed, coded as 2 (no).

Fig 1 | Criteria for coding factors observed in video recordings.

the stairs (coded "0"); and (c) active ascent (coded "1") versus passive ascent (coded "0") where active ascent was using the stairs or climbing the escalator, and passive ascent was standing on the escalator. All logistic models were adjusted by entering factors that were significantly different (based on chi-square tests) between sign and no-sign conditions—age, sex, ethnicity, body shape, shoe type, luggage, and traffic volume—as covariates in the models. All statistical tests were two-tailed with $p < .05$ considered significant. Data analyses were conducted using R (R Foundation for Statistical Computing; Vienna, Austria).

RESULTS

A total of 13,544 people were video recorded ascending either by escalator or by stairs during the 20 days of data collection. Most ascenders were adults (83%), 14 percent were coded as older adults (seniors), and 3 percent youth. Ascenders were predominantly male (63%), white (81%; vs. 4% black and 15% "Other") and coded as normal weight (82%). The percentage of ascenders on days with versus without signs were as follows: stair use, 6.9 versus 3.6 percent; escalator standing, 75.2 versus 76.0 percent; and escalator climbing, 18.5 versus 20.4

percent. See [Supplementary Material](#) for full output from each regression model, including the odds ratio, 95% CI, and p -value for all covariates.

Stair use versus escalator use

[Figure 2](#) compares stair use to escalator use across sign conditions, the method of comparison used in nearly all other stair-use interventions. The odds of ascending the stairs more than doubled on days with signs compared with days without signs (OR = 2.25; 95% CI = 1.90–2.68; $p < .001$; [Fig. 2b](#)).

Escalator climbing versus escalator standing or stair use

[Figure 3](#) compares escalator climbing against the other two methods of ascent. On days with signs (vs. days without signs), odds of climbing the escalator (vs. standing on the escalator or using the stairs) decreased 10 percent (OR = 0.90; 95% CI = 0.82–0.99; $p = .028$; [Figure 3b](#)).

Active ascent (stair use or escalator climbing) versus passive ascent (escalator standing)

[Figure 4](#) compares the two active ascent methods combined (using the stairs or climbing the escalator) with passive ascent (standing on the escalator). There was a small (15%), statistically significant, increase in

(a) Percent of participants using stairs vs. escalator **(b) Adjusted odds of stair use on days with signs vs. without signs**

Ascent Method	OR (95% CI) ^a	p
Used escalator	1.00 (referent)	
Used stairs	2.25 (1.90, 2.68)	< .001

^aOR = Odds ratio adjusted for age, sex, ethnicity, body shape, shoe type, luggage and traffic volume; CI = Confidence interval

Fig 2 | Stair use. (a) Percent of participants using stairs versus escalator. (b) Adjusted odds of stair use on days with signs versus days without signs.

the odds of active ascent attributed to signs prompting stair use (OR = 1.15; 95% CI = 1.05–1.25; $p = .002$; Fig. 4b). Conversely, these results also indicate that there was a small (13%), statistically significant, decrease in the odds of passive ascent, that is, escalator standing (OR = 0.87; 95% CI = 0.80–0.95; $p = .002$). These figures are computed by inverting the odds for active ascent.

DISCUSSION

Increasing physical activity has been a core public health objective for nearly four decades [10]. One method recommended by the CDC's Community Preventive Services Task Force is to introduce stair-use prompts at points of choice between stairs and escalators/elevators "... on the basis of strong evidence of its effectiveness in moderately increasing levels of *physical activity*, as measured by an increase in the percentage of people choosing to take the stairs rather than an elevator or escalator" [emphasis added] [11].

In our study, when stair use was compared with escalator use, point-of-choice prompts increased stair use by 115 percent, confirming previous findings [4,12], including our own [13], that prompts are an effective means of changing stair-use behavior. However, to more accurately assess the impact on physical activity, we also compared active ascent

(stair use or escalator climbing) with passive ascent (escalator standing) and found prompts increased active ascent by only 15 percent.

Considering the three ascent methods separately, our results indicated that stair use increased on days with point-of-choice prompts, whereas both escalator climbing and escalator standing decreased. One interpretation is that, upon seeing the sign prompts, some of those who were already disposed to climb the escalator were prompted to make an even greater effort and used the stairs. If the interpretation is correct and our findings are replicated in other populations and settings, then the effect estimates based on comparing stair use versus escalator use reported by many previous studies may represent over-estimates of the increase in physical activity resulting from stair-use prompts.

In contrast to our results, Andersen et al. found that prompts designed to increase stair use increased both types of active ascent [5], with larger increases observed for escalator climbing than for stair use. If the results of Andersen et al. are replicated in other populations and settings, then previously reported stair-use prompt effect estimates based on comparing stair use versus escalator use could represent under-estimates of the increase in overall physical activity resulting from stair-use prompts. There are notable differences between the study

(a) Percent of participants climbing the escalator **(b) Adjusted odds of escalator climbing on days with signs vs. without signs**

Ascent Method	OR (95% CI) ^a	p
Stood on escalator or used stairs	1.00 (referent)	
Climbed escalator	0.90 (0.82, 0.99)	.028

^aOR = Odds ratio adjusted for age, sex, ethnicity, body shape, shoe type, luggage, and traffic volume; CI = Confidence interval

Fig 3 | Escalator climbing. (a) Percent of participants climbing the escalator. (b) Adjusted odds of escalator climbing on days with signs versus days without signs.

(a) Percent of participants using active ascent vs. passive ascent **(b) Adjusted odds of active ascent on days with signs vs. without signs**

Ascent Method	OR (95% CI) ^a	p
Stood on escalator	1.00 (referent)	
Used stairs or climbed escalator	1.15 (1.05, 1.25)	.002

^aOR = Odds ratio adjusted for age, sex, ethnicity, body shape, shoe type, luggage, and traffic volume; CI = Confidence interval

Fig 4 | Active ascent. (a) Percent of participants using active ascent versus passive ascent. (b) Adjusted odds of active ascent on days with signs versus days without signs.

of Andersen et al. and ours that could account for the contrasting results. First, the study of Andersen et al. was conducted at the Baltimore Convention Center among attendees of a scientific conference on physical activity; our sample was drawn from the general population of San Diego International Airport users. Second, Andersen et al. coded participants as “walked up the escalator” only if they walked all the way up the escalator. We tailored our measure for an airport setting considering sometimes high pedestrian traffic and the presence of luggage that could prevent uninterrupted escalator climbing. Therefore, ascenders were coded as “escalator climbers” if they walked or ran at least half the length of the escalator. Finally, Andersen et al. relied on research assistants at the venue to observe, count, and code characteristics of stair and escalator ascenders in-person. Observers are less readily concealed than cameras and thus more likely to influence behavior. Also, accurate real-time observation and recording can be difficult during periods of high pedestrian traffic. The present study used concealed cameras to make video recordings that were subsequently coded by trained research assistants who could view recordings at a slow speed and as often as needed.

By itself, walking or even running up a single flight of stairs does not constitute a substantial amount of physical activity, and walking up an escalator constitutes even less. But the goal of prompting incidental physical activities like stair use or escalator walking is to promote behavior change in all aspects of life, to encourage the public to take advantage of multiple opportunities for activity that together may contribute to their overall health. To that end, stair studies play an important part in efforts to promote active living [14] and change the built environment [15], all with the aim of providing greater opportunities for physical activity during the course of everyday life. The ultimate goal of this line of investigation is to help understand how to develop a variety of strategies across a number of settings that can each make a small contribution to a large cumulative improvement in public health.

There are limitations to take into account when interpreting our results. First, the target behavior of the intervention was stair use (not active ascent). Ideally, we would have tested the effects of stair use prompts alone, escalator climbing prompts alone, and the two types of prompts combined. Second, our analysis of active versus passive ascent treated those individuals who climbed (walked or ran up) the escalators as equivalent to those who used the stairs, for the purpose of contrasting with participants who merely stood on the escalator. However, because escalators are moving while ascenders climb, the overall energy expended by climbing escalators is less than the energy expended by climbing stairs, for a given speed, making the two methods of ascent similar, but not equivalent.

Third, our study was conducted in an airport setting during a busy time of the day. Congested escalators and/or passengers carrying luggage and/or traveling with small children could make active ascent prohibitively difficult. This last limitation raises the issue of confounding. Because our study design was quasi-experimental, it was not possible to randomly assign participants to experimental conditions (days with vs. days without signs), which would have increased the likelihood that measured and unmeasured factors were balanced across conditions. We addressed the issue in part by reviewing the video recordings to measure factors that might have differed between conditions, and adjusting for these in statistical models—including factors that could inhibit active ascent, such as luggage usage and pedestrian traffic volume. However, residual confounding from measurement error and unmeasured variables may still exist. Our study design was not capable of providing the degree of confidence in findings that would have resulted from a fully controlled trial.

Although the literature contains strong evidence that stair-use prompts can increase *stair use* in a range of settings and populations, the results from our study and those of Andersen et al. highlight the importance of measuring (and possibly intervening on) escalator climbing, a behavior which, like stair use, requires greater energy expenditure than needed for standing. Since the two studies found contrary effects of stair-use prompts on increasing escalator climbing, more research is warranted to evaluate whether point-of-choice prompts can increase escalator climbing, and future studies should test prompts specifically designed to increase both stair climbing and escalator climbing. Investigators should proceed with caution, however, because little is known about the risks associated with climbing escalators. Escalator use has been associated with injurious falls in airports and other settings, primarily among elderly and young children, although it is unknown whether the risk exceeds that associated with using stairs [16, 17]. Any studies promoting active ascent should take steps to prevent injuries. Finally, we recommend that all future stair-use studies evaluate escalator climbing along with stair use so that changes in physical activity can be more accurately assessed.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Translational Behavioral Medicine* online.

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Compliance with Ethical Standards

Conflict of Interest: Authors John Bellettiere, Ben Nguyen, Sandy Liles, Vincent Berardi, Marc A. Adams, Paddy Dempsey, Yael Benporat, Jacqueline Kerr, Andrea Z. LaCroix, and Melbourne Hovell declare that they have no conflict of interest.

Authors' Contributions: All authors were involved in the preparation of this manuscript and read and approved the final version.

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Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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