Promoting Routine Stair Use
Evaluating the Impact of a Stair Prompt Across Buildings

Karen K. Lee, MD, MHSc, Ashley S. Perry, MPH, Sarah A. Wolf, MPH, RD, Reena Agarwal, MD, MPH, Randi Rosenblum, PhD, Sean Fischer, PhD, Victoria E. Grimshaw, MPH, Richard E. Wener, PhD, Lynn D. Silver, MD, MPH

Background: Although studies have demonstrated that stair prompts are associated with increased physical activity, many were conducted in low-rise buildings over a period of weeks and did not differentiate between stair climbing and descent.

Purpose: This study evaluated the impact of a prompt across different building types, and on stair climbing versus descent over several months.

Methods: In 2008–2009, stair and elevator trips were observed and analyzed at three buildings in New York City before and after the posting of a prompt stating "Burn Calories, Not Electricity" (total observations=18,462). Sites included a three-story health clinic (observations=4987); an eight-story academic building (observations=5151); and a ten-story affordable housing site (observations=8324). Stair and elevator trips up and down were recorded separately at the health clinic to isolate the impact on climbing and descent. Follow-up was conducted at the health clinic and affordable housing site to assess long-term impact.

Results: Increased stair use was seen at all sites immediately after posting of the prompt (range=9.2%–34.7% relative increase, $p<0.001$). Relative increases in stair climbing (20.2% increase, $p<0.001$) and descent (4.4% increase, $p<0.05$) were seen at the health clinic. At both sites with long-term follow-up, relative increases were maintained at 9 months after posting compared to baseline: 42.7% ($p<0.001$) increase in stair use at the affordable housing site and 20.3% ($p<0.001$) increase in stair climbing at the health clinic.

Conclusions: Findings suggest that the prompt was effective in increasing physical activity in diverse settings, and increases were maintained at 9 months.
(Am J Prev Med 2012;42(2):136–141)

Introduction

Stair use is a readily available form of physical activity that is associated with numerous physiologic benefits, including greater lower-limb strength[1] and reduced cholesterol levels.[2] Stair climbing is particularly beneficial, eliciting oxygen and heart rate responses sufficient to produce measurable cardiovascular benefits.[3] In one study,[4] men who regularly climbed a moderate number of stairs (20–34 floors a week) had a 29% lower risk of stroke. Stair climbing is also expected to assist in weight control.[5]

Despite its advantages, stair use is low when automated alternatives are present. In a review of stair use interventions, Eves and Webb[6] report median baseline stair use to be 5.4% (range=1.7%–8.5%) when the alternative is an escalator at shopping centers, airports and banks, and 35.7% (range=11.1%–69.1%) when the alternative is an elevator at worksites. Stair prompt signs, which are point-of-decision cues placed near elevators and escalators, may represent a low-cost method to encourage passersby to take the stairs over the passive transport alternative.[7] Increases in stair use associated with prompts have been shown to range from 5.5% to 128.6%, with a median relative increase of 50.0%.[7–9]

From the Division of Health Promotion and Disease Prevention (Lee, Perry, Wolf, Rosenblum, Fischer, Grimshaw, Silver), New York City Department of Health and Mental Hygiene, Queens; the Montefiore Medical Center (Agarwal), Bronx; and the Polytechnic Institute of New York University (Wener), Brooklyn, New York

Address correspondence to: Karen K. Lee, MD, MHSc, Director of the Built Environment Program, New York City Department of Health and Mental Hygiene, 42-09 28th Street, Queens NY 11101. E-mail: klee3@health.nyc.gov.

0749-3797/$36.00
doi: 10.1016/j.amepre.2011.10.005

Previous studies establishing the effectiveness of prompts in increasing stair use have had several limitations. In one review, studies were conducted mostly in a single-escalator alternative setting, such as a two-story train station or shopping center.[7] Several studies have moved beyond retail and transportation settings to evaluate the impact of prompts in workplace settings, and most of these studies reported increases in stair use following the posting of prompts.

For example, Eves and colleagues[10] reported "an unequivocal increase" in stair use following the posting of prompts in a five-story office building. Similarly, Kerr et al.[11] and Vanden Auweele et al.[12] reported positive effects following posting of stair prompts in five- and four-story office buildings, respectively. Other studies,[13–15] however, have reported no change in stair use following the introduction of stair prompts in workplace settings including in three- and eight-story buildings. Thus, the effectiveness of prompts in increasing stair use in workplace settings remains unclear.

Few studies have evaluated the impact of prompts in residential settings and none of the studies published to date have evaluated the impact of the same stair prompt on stair use across different building types, including buildings of varying uses, heights, and locations. Most studies also have not established whether prompts have a differential impact on stair climbing and stair descent, an important question given differences in the physiologic impacts of the two activities.[3,16] Finally, many of these studies did not evaluate the impact of prompts over an extended period of time, and therefore evidence on potential long-term behavioral impacts is lacking.

The present study of the initial phase of a public health intervention to post permanent stair prompts in elevator buildings across New York City addresses current gaps in knowledge on the impact of stair prompts in different settings over different time periods. It was hypothesized that the presence of point-of-decision stair prompts with a stair climbing message increases stair use in different buildings, increases stair climbing and descent, and the impact of these prompts would be sustained over an extended period of time.

Methods

Site Selection

Building-level variables considered in site selection included building use, height and location. The number of sites and the actual sites themselves were also chosen based on real-world feasibility for conducting this evaluation study, including support from the management of buildings and layout of the building lobby. The selected sites were: (1) a three-story health clinic in northern Manhattan where baseline data were to be collected as part of a related additional intervention to improve the stairs; (2) an eight-story academic building in central Brooklyn where one of the authors taught; and (3) a ten-story affordable housing site in South Bronx that had a pre-existing relationship with several of the authors.

The building populations differed substantially, with the health clinic serving a diverse group of patients and staff of all ages, the academic building serving primarily a student population, and the affordable housing site primarily serving an African American and Latino mixed-age population that met the income restrictions for the building. Stairwells were described qualitatively by building staff and users and corroborated by study observers as well-marked, well-lit, well-maintained, and safe.

Intervention

The intervention consisted of posting stair prompts directly adjacent to elevators and stairwells, which varied in distance from each other and the entrance based on the site (Figure 1). Printed on a bright green background, the prompt urged viewers to "Burn Calories, Not Electricity. Take the Stairs!" and featured an image of a stick figure climbing stairs (Figure 2). The submessage informed viewers that "Walking up the stairs just 2 minutes a day helps prevent weight gain. It also helps the environment." Prompts were posted on all floors of the health clinic and affordable housing site, but were permitted only in the lobby of the academic building. Given the high number of Spanish-speaking residents at the affordable housing site, Spanish-language prompts were posted next to the English prompts at that site.

On request from our partners at the affordable housing site, the NYC Health Department assisted with a health education event 7 weeks after the introduction of the prompt to increase awareness of the prompt and health issues related to obesity. Pamphlets containing nutrition and exercise tips were distributed and stair use was discussed as a strategy for increasing physical activity, maintaining a healthy weight, and preventing chronic disease.

Figure 1. Stair prompt introduced by City of New York, May 2008

Figure 2. Stair prompt on display at the elevator in the lobby of the health clinic

Data Collection

In 2008–2009, all vertical trips (elevator and stair) originating from or terminating on the lobby level of each site were tallied on observation forms by three research staff and four student interns. Stair and elevator trips between the basement and upper floors that did not stop on the lobby level were not recorded. Because of the presence of a display screen on the wall next to the elevator at the health clinic that indicated the floor location of the elevator, it was possible to separately tally ascent versus descent for elevator trips as well as stair trips at this site.

The hours of observation for each data collection period were distributed over multiple days, in approximately week-long segments, during "high traffic" periods as reported by key building staff. Hour-long counts of baseline and 1-week post-prompt data were as follows: health clinic (8 hours baseline, 8 hours post); academic building (12 hours baseline, 11 hours post); and affordable housing site (13 hours baseline, 16 hours post). Given the need to conduct unobtrusive observations, it was not possible to study the personal characteristics of stair users.

Long-term follow-up was conducted at the health clinic and affordable housing site. The academic building was added as an additional site for evaluation after the initial study was designed, and resources to conduct long-term follow-up were not available. At the health clinic, stair and elevator use were observed for a period of 8 hours at 9 months post-prompt. At the affordable housing site, stair and elevator use were observed for 12 hours at three additional data collection periods: (1) 6 weeks post-prompt (1 week prior to the health education event); (2) 9 weeks post-prompt (2 weeks after health education event); and (3) 9 months post-prompt (7 months after health education event).

Prior to data collection, inter-rater reliability was assessed at each site. During five periods of 15 minutes or longer, observers independently and simultaneously observed stair and elevator use. Tallies recorded by each observer were then compared and the percentage of inter-rater agreement across two or more observers was calculated.

Statistical Analyses

In 2008–2009, baseline and post-prompt stair and elevator use rates were calculated, as were relative changes to enable accurate cross-site comparisons. Relative change was calculated by dividing the raw change over the original rate (e.g., a change from 10% to 15% would be a relative increase of (15%–10%)/10% = 50%). Uncorrected chi-square analyses were used to test the significance of observed changes in stair use. An extended Mantel-Haenszel chi-square test was used to test for linear trends over time for follow-up observations conducted at the health clinic and the affordable housing site.

Results

A total of 18,462 vertical trips by stair or elevator were observed: 4987 at the health clinic; 5151 at the academic building; and 8324 at the affordable housing site. The average inter-rater agreement among observers was high: 98.1% (academic building, 100%; health clinic, 97.7%; and housing building, 96.6%). Stair use across days within individual observation periods for each site exhibited acceptable distributions (skewness≤1.2; kurtosis≤2.4), and extreme scores were not observed on any particular day (all absolute z scores<1.96).

There was significant variability in baseline stair use: 70.1% at the health clinic; 25.1% at the academic building; and 13.0% at the affordable housing site. Relative stair use increased immediately following posting of the prompt at each site (Table 1): 9.2% at the health clinic (absolute change=6.4%); 34.7% at the academic building (absolute change=8.7%); and 33.6% at the affordable housing site (absolute change=4.4%).

At the health clinic, stair climbing increased 20.2% (absolute change=11.3%) and stair descent increased 4.4% (absolute change=3.5%). Nine months post-prompt, stair climbing remained 20.3% higher than the initial baseline (absolute change=11.4%; Table 2). For stair climbing, the extended Mantel-Haenszel chi-square test for linear trends was significant ($p<0.001$).

At the affordable housing site, stair use increased from the initial baseline

Table 1. Cross-site comparison of stair use, baseline to 1 week post-prompt, %

	Baseline	1 week post-prompt	Relative increase	*p*-value (two-tail)	χ^2
Three-story health clinic (n=3431)	70.1	76.5	**9.2**	<0.001	17.57
Eight-story academic building (n=5151)	25.1	33.8	**34.7**	<0.001	46.72
Ten-story affordable housing site (n=4313)	13.0	17.4	**33.6**	<0.001	15.65

Note: Boldface indicates significance.

Table 2. Stair use at the three-story health clinic, %

	Baseline (April 2008)	1 week post-prompt (July 2008)				9 months post-prompt (March 2009)			
		Stair use	Relative increase[a]	*p*-value (two-tail)	χ^2	Stair use	Relative increase[a]	*p*-value (two-tail)	χ^2
All vertical trips (*n*=4987)	70.1	76.5	**9.2**	<0.001	17.57	72.1	2.9	0.227	1.47
Stair climbing (*n*=2064)	56.0	67.3	**20.2**	<0.001	18.17	67.4	**20.3**	<0.001	16.91
Stair descent (*n*=2923)	79.5	83.0	**4.4**	0.046	3.984	75.7	−4.75	0.059	3.56

[a]Compared to baseline
Note: Boldface indicates significance.

by 44.4% (absolute change=5.8%) at 6 weeks post-prompt; 67.6% (absolute change=8.8%) at 9 weeks post-prompt and 2 weeks after the health education event; and 42.7% (absolute change=5.6%) at 9 months post-prompt (Figure 3 and Table 3). The extended Mantel-Haenszel chi-square test for linear trends was significant ($p<0.001$).

Discussion

Impact of the Prompt Across Building Types and Locations

The hypothesis that there would be increases in stair use across different building types was supported. The observed relative increases in stair use are within the range of those reported by previous studies,[7] although overall results are lower than the median increase of 50.0%.[9] It should be noted, however, that many previous studies were conducted in low-rise escalator buildings; the current study, in contrast, was conducted in three elevator buildings, two of which were mid-rise.

The relative increase in stair use was greatest at the academic building, which may be explained at least partially by characteristics of the building's largely student population. Variations in mobility and other characteristics of building users may partially explain observed differences in the impact of the prompt across the sites. However, it also should be noted that because prompts were posted in the lobby only of the academic building, stair use may not have been as high relative to the other buildings for trips originating from other floors that were unobserved in the current study. Although relative increases in overall stair use were lowest at the health clinic, it also had the highest baseline stair use and the highest stair use after the intervention. Given that a certain percentage of the population cannot be expected to take the stairs, stair use at the health clinic may have already been approaching its upper limit.

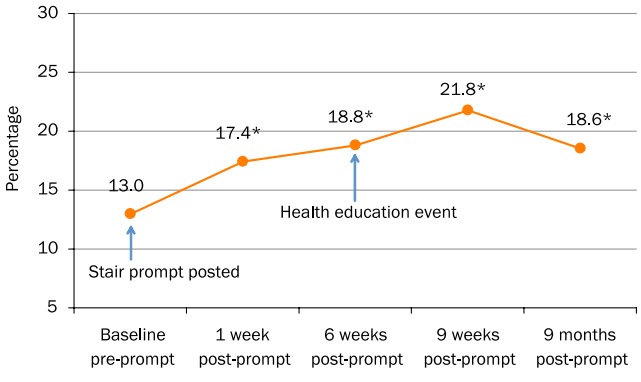

Figure 3. Stair use at the ten-story affordable housing site, baseline to 9 months post-prompt (*n*=8324)
Note: *Relative increase in stair use from baseline is significant ($p<0.001$).

Impact of the Prompt on Stair Climbing and Descent

In their review of interventions, Eves and Webb hypothesized that prompts may have a greater impact on stair descent than stair climbing,[6] calling into question the capability of such interventions to produce meaningful increases in moderate- or vigorous-intensity physical activity. This hypothesis was supported by the findings of a study conducted in a four-story and nine-story worksite building,[17] but contradicted by a subsequent study of a five-story public sector building.[10] Results from the health clinic suggest that prompts are associated with increases in both activities. However, at that site, only stair climbing increased at 9 months, contrary to the hypotheses put forth by Eves and Webb[6] and others. This may be partially explained by the fact that the prompt's submessage and image specifically address stair climbing. Differences in the increase in stair use associated with the prompt may also at least partly be attributable to differences in baseline stair use for stair climbing and descent, which were 56.0% and 79.5%, respectively.

Impact of the Prompt Over an Extended Period of Time

Stair use in each of the long-term follow-up periods at the affordable housing site exceeded stair use during the ini-

Table 3. Stair use at the ten-story affordable housing site

	Baseline (May/June 2008)	1 week post-prompt (June 2008)	6 weeks post-prompt (and 1 week before health education; July 2008)	9 weeks post-prompt (and 2 weeks after health education; July/August 2008)	9 months post-prompt (February/March 2009)
Vertical trips observed	1953	2360	1257	1358	1396
Stair use, %	13.0	17.4	18.8	21.8	18.6
Relative increase,[a] %	—	**33.6**	**44.4**	**67.6**	**42.7**
p-value, two-tail		<0.001	<0.001	<0.001	<0.001
χ^2	—	15.65	19.68	44.69	19.31

[a]Compared to baseline
Note: Boldface indicates significance.

tial post-prompt period, suggesting that the impact of the prompt on stair use grew in the weeks following its introduction and then stabilized. The Mantel-Haenszel chi-square test for linear trends suggests that stair use increased over time after posting of the stair prompt. These findings contradict the results of a previous study,[15] which indicated that the impact of a prompt declined in a matter of weeks following posting in a six-story healthcare facility. However, unlike the current study, the prompt was removed during the post-prompt observation period. In addition, sustained increases may be related to the repeated exposure and/or possible social/cultural shifts that could occur over time in residential and workplace settings.

A comparison of time points at the affordable housing site showed a modest, but not significant, additional increase in stair use 2 weeks after the health education event. However, this increase was not maintained at 9 months. This suggests that such events may contribute to temporary and additional increases in stair use when used in conjunction with a stair prompt, but more study is necessary. Other studies have yet to examine the impact of combining stair prompts with educational events, although Vanden Auweele et al.[12] reported that distribution of an e-mail from a physician describing the health benefits of stair use was associated with an increase in stair use beyond that associated with the initial introduction of stair prompts.

Strengths and Limitations

The study builds on the literature by evaluating the impact of point-of-decision prompts on stair ascent and descent in different building types and heights. In addition, the current study is one of the few to examine whether the impact of prompts is sustained over time. The evaluation contributes to the generalizability of current knowledge by capitalizing on the opportunity to evaluate a large-scale public health intervention to post permanent stair prompts citywide amid real-world variations in implementation.

There are several limitations to the present study. The lack of comparison to buildings with similar characteristics and user populations that did not have the stair prompt intervention weakens the causal interpretation that can be made. Future research should include a larger sample of buildings, including a comparison group of similar building types and users, to help tease apart other factors that potentially could influence stair use. In addition, the current study was unable to examine the actual number of floors taken, an issue that the literature overall has not yet adequately addressed. Floor thresholds can explain more precisely how stair prompts affect health, and how building heights mediate their impact.

Another limitation is the potential for real-world site conditions to have influenced the magnitude of impacts at each site. For example, increases in stair use may not have occurred if the stairs in the current study were less visible or located farther from the entrance than the elevators,[18] as is the case in many buildings. In addition, the stairwells in the study were reported to be well lit, clean, and safe. Many stairwells, however, are not well maintained and in some cases may pose personal or physical safety risks.[19]

This limitation, however, highlights additional opportunities to promote routine stair use: combining stair prompt interventions with aesthetic and structural changes enhancing the visibility, accessibility, convenience, and attractiveness of stairwells,[5,11,18] strategies provided in the *Active Design Guidelines*.[20] Such initiatives require collaboration with architects, contractors, and building owners and managers. Though possibly requiring greater time and financial commitment than posting prompts, such efforts may prove even more effective than prompts alone.

Conclusion

This study demonstrates that the introduction of a stair prompt is associated with increased stair use across building types, including low- and mid-rise elevator buildings and buildings with high baseline stair use. Results suggest that prompts are not limited to promoting stair descent. At the health clinic, the sustained increase in observed stair use was solely for stair climbing with a prompt message promoting stair climbing. Also, the findings indicate that the impact of the prompt was maintained over 9 months, suggesting that stair prompt interventions can be an effective long-term strategy for increasing routine physical activity levels. Taken together, these findings suggest that this simple, low-cost intervention can produce meaningful improvements in the population's daily physical activity over time.

No financial disclosures were reported by the authors of this paper.

References

1. Loy SF, Conley LM, Sacco ER, et al. Effects of stairclimbing on VO_2max and quadriceps strength in middle-aged females. Med Sci Sports Exerc 1994;26(2):241–7.
2. Boreham CA, Wallace WF, Nevill A. Training effects of accumulated daily stair-climbing exercise in previously sedentary young women. Prev Med 2000;30(4):277–81.
3. Teh KC, Aziz AR. Heart rate, oxygen uptake, and energy cost of ascending and descending the stairs. Med Sci Sports Exerc 2002;34(4):695–9.
4. Lee IM, Paffenbarger RS Jr. Physical activity and stroke incidence: the Harvard alumni health study. Stroke 1998;29(10):2049–54.
5. Zimring C, Joseph A, Nicoll GL, Tsepas S. Influences of building design and site design on physical activity: research and intervention opportunities. Am J Prev Med 2005;28(2S2):186–93.
6. Eves FF, Webb OJ. Worksite interventions to increase stair climbing: Reasons for caution. Prev Med 2006;43(1):4–7.
7. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med 2002;22(4S):73–107.
8. Soler RE, Leeks KD, Buchanan LR, Brownson RC, Heath GW, Hopkins DH; Task Force on Community Preventive Services. Point-of-decision prompts to increase stair use. A systematic review update. Am J Prev Med 2010;38(2S):S292–S300.
9. Guide to Community Preventive Services. Environmental and policy approaches to physical activity: point-of-decision prompts to encourage use of stairs. www.thecommunityguide.org/pa/environmental-policy/podp.html.
10. Eves FF, Webb OJ, Mutrie N. A workplace intervention to promote stair climbing: greater effects in the overweight. Obesity 2006;14(12):2210–6.
11. Kerr NA, Yore MM, Ham SA, Dietz WH. Increasing stair use in a worksite through environmental changes. Am J Health Promot 2004;18(4):312–5.
12. Vanden Auweele Y, Boen F, Schapendonk W, Dornez K. Promoting stair use among female employees: the effects of a health sign followed by an e-mail. J Sports Exerc Phys 2005;27(2):188–96.
13. Boutelle KN, Jeffery RW, Murray DM, Schmitz MK. Using signs, artwork, and music to promote stair use in a public building. Am J Public Health 2001;91(12):2004–6.
14. Coleman KJ, Gonzalez EC. Promoting stair use in a U.S.–Mexico border community. Am J Public Health 2001;91(12):2007–9.
15. Marshall AL, Bauman AE, Patch C, Wilson J, Chen J. Can motivational signs prompt increases in incidental physical activity in an Australian health-care facility? Health Educ Res 2002;17(6):743–9.
16. Bassett DR, Vachon JA, Kirkland AO, Howley ET, Duncan GE, Johnson KR. Energy cost of stair climbing and descending on the college alumnus questionnaire. Med Sci Sports Exerc 1997;29(9):1250–4.
17. Kerr J, Eves F, Carroll D. Can posters prompt stair use in a worksite environment? J Occup Health 2001;43:205–7.
18. Nicoll G. Spatial measures associated with stair use. Am J Health Promot 2007;21(4S):346–52.
19. U.S. Department of Housing and Urban Development. Stair safety: a review of the literature and data concerning stair geometry and other characteristics. Washington DC: Office of Policy Development and Research, 1992.
20. The City of New York. Active design guidelines: promoting physical activity and health in design. New York NY: The City of New York, 2010. www.nyc.gov/adg.