Health Promoting Community Design

Trail Characteristics as Correlates of Urban Trail Use

Kim D. Reynolds, PhD; Jennifer Wolch, PhD; Jason Byrne, BA; Chih-Ping Chou, PhD; Guanjun Feng, PhD; Susan Weaver, MA, MPl; Michael Jerrett, PhD

Abstract

Purpose. *The purpose of this study was to identify the environmental correlates of urban trail use.*

Design. *Three multiuse urban trails at least 15 miles in length were selected. Trails were divided into one-half-mile segments ($N = 102$ total segments) and marked in the field. An audit of each trail was completed identifying built environmental features. A cross-sectional count of trail users was completed at each segment estimating the type of use, age, gender.*

Setting. *Data collection occurred on urban trails in Chicago, Dallas, and Los Angeles.*

Subjects. *Trained observers counted 17,338 users across the three trails.*

Measures. *The SPACES for Trails instrument was used, and a trail count data collection sheet was developed.*

Analysis. *Univariate and multivariate Poisson regressions controlling for location of trail and density of the population within 1 mile of the trail.*

Results. *Positive associations with trail use were observed for mixed views ($\beta = .33$, $p < .0001$), streetlights ($\beta = .30$, $p < .0001$), good trail condition ($\beta = .28$, $p < .0001$), and the presence of cafés ($\beta = .38$, $p < .0001$) and other trailside facilities ($\beta = .08$, $p < .0001$). Negative associations were observed for litter ($\beta = -.22$, $p < .0001$), noise ($\beta = -.41$, $p < .0001$), higher vegetation density ($\beta = -.10$, $p < .001$), drainage features ($\beta = -.67$, $p < .0003$), natural areas adjacent to the trail ($\beta = -.39$, $p < .0001$), and tunnel present ($\beta = -.20$, $p < .04$).*

Conclusions. *These correlates should be confirmed in other studies and if supported should be considered in the promotion and design of urban trails. (Am J Health Promot 2007;21[4 Supplement]:335–345.)*

Key Words: Exercise, City Planning, Environment Design, Recreation, Prevention Research. Manuscript format: research; Research purpose: relationship testing; Study design: nonexperimental; Outcome measure: behavioral; Setting: local community; Health focus: fitness/physical activity; Strategy: built environment; Target population age: youth/adults/seniors; Target population characteristics: geographic location

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INTRODUCTION

Obesity is a major public health challenge that spans age, sex, and ethnic/racial differences.[1–5] With obesity come other health problems linked to sedentary lifestyles, including coronary heart disease, diabetes mellitus, and several forms of cancer.[6–9] Increasingly obesity research is moving beyond the study of individuals' attributes (such as genetics and behavior) and their relationships to obesity, to analysis of the built environment.[10–14] Recent public health studies have concluded that residents of low-density, auto-oriented communities are at higher risk of obesity.[3,10,11,13–17]

Along with other elements, such communities typically lack attractive walking, hiking, and cycling infrastructure, such as urban multiuse trails.[17,18] Urban trails are linear features designed for walking, cycling, jogging, skating, and even horseback riding. They are typically paved, with surfaces of asphalt or concrete, and traverse a range of landscapes including lakefronts, woodlands, and ocean shorelines. Urban trails also pass through a diverse range of land uses, from factories and residential areas to vacant land and nature preserves. Such trails may be referred to as greenways where they have been constructed along abandoned railway lines or other infrastructure corridors, bikeways where they have been designed specifically for bicycle use, or hiking trails where they have been designed for hikers and pass through more scenic landscapes.[19,20] Studies of urban trails find that accessing nature, exercising, commuting, and relaxation are key motivations for trail use.[7,19–23]

Urban trail users are predominantly male, White, young to middle-aged, wealthy, and well educated, and live in households without dependent children, typically residing within 5 miles of the trail.[19,24–26] An array of activities have been reported on urban trails, including cycling, jogging, walking, skating, horse-riding, and even cross-country skiing.[6,19,21,24–27] Many studies have identified cycling as the dominant trail activity, oftentimes overshadowing other activities by as much as 80%.[28] Nonetheless, considerable variability characterizes many trails, with some sections being heavily used for one type of activity while other sections have a different predominant use. Hunter and Huang[28] reported that average trail use ranged from a low of 25 users per hour on the Iowa Heritage Trail, a rural trail, to a high of 240 users per hour on urban trails in New York. Research by Lindsey[21] estimated that monthly use ranged from 2500 users on the White River Trail to 41,500 users on the Monon Trail in Indiana. In a later study, Lindsey and Nguyen[20] used infrared monitors on five greenway trails in Indiana, finding substantial variations in user volume. Monthly trail traffic ranged from 5218 users to 55,148 users, with significant intra and intertrail variations: between trail segments, over different times of the day, over different days of the week, and over different seasons. Researchers have also described significant spatial and temporal (hourly, diurnal, weekly, seasonal, and annual) variability in utilization.[20,21,27,28]

Many factors have been suggested as explaining variations in trail use, including seasonality, weather events, and crime.[28] Concerns with personal and neighborhood safety, dog droppings, unleashed dogs, and speeding cyclists have also been suggested as potential limiting factors,[7,21,27] as have trail location and accessibility.[21,25,29] Variations in urban trail use also appear to be a function of the physical features of the trail and its setting: trail-adjacent land uses, trail surface materials and condition, trail maintenance, adjoining vegetation, traffic and road crossings, and inadequate facilities. To date, however, only limited research has been undertaken on characterizing the physical attributes of urban trails and then linking such attributes to trail use patterns. Indeed, there are only a few instruments for the empirical assessment of the built environment from a physical activity perspective.[17]

The purpose of this study was to identify characteristics of the built and social environment of urban trails that are associated with levels of trail use. Understanding these characteristics and the direction of their relationship with trail use can assist in the design of future urban trails and in efforts to maximize use of existing trails. This paper reports results of research undertaken on urban trails in Chicago, Dallas, and Los Angeles during 2004. The specific hypothesis examined here is that the volume of urban trail use is related to characteristics of the trail itself and areas immediately adjacent to the trail.

METHODS

Design

The analyses in this manuscript were based on a larger study (Research on Urban Trail Environments, or ROUTES) designed to identify and test predictors of urban trail use.[30,31] In this manuscript, data are used from three steps in the larger research study. First, three shared-use trails were identified in different urban areas of the United States using carefully defined criteria that ensured diversity of climate across trail sites, variability of metropolitan form (auto-orientation), and race/ethnicity and income of the population in the areas traversed by each trail. The three multiple-use urban trails were located in Chicago, Illinois (Chicago Lakefront Trail), Dallas, Texas (White Rock Lake Trail), and Los Angeles, California (Los Angeles River Trail). Maps for the Chicago, Dallas, and Los Angeles trails are provided in Figures 1, 2, and 3 respectively. The trails were divided into segments one-half mile in length, yielding 102 segments (Chicago, n = 34 segments; Dallas, n = 30 segments; Los Angeles, n = 38 segments). Second, an audit of each trail was completed to determine the physical characteristics of the trail landscape (e.g., slope, trees and green cover) and trailside urban design features (e.g., residential mix, connectivity). The Systematic Pedestrian and Cyclist Environmental Scan (SPACES) audit instrument was adapted for use on urban trails and utilized to audit the three selected trails.[32] Third, a trail count was conducted to estimate the amount and type (i.e., walking, cycling, horseback riding) of trail use and to identify basic characteristics of trail users, including age and gender, for each segment of each trail. The data were collected in Chicago from June 17 to 22, 2004; in Dallas from July 9 to 13, 2004; and in Los Angeles from December 6 to 9, 2004. Despite the difference in seasons, weather in all three locales was generally conducive to outdoor activities during the data collection dates, with daily maximum temperatures averaging 73.1° F in Chicago, 94.8° F in Dallas, and 86.9° F in Los Angeles. There was one day of colder weather (64° F) and intermittent rain in Chicago and normally high humidity in Dallas; skies were clear in Los Angeles. This research was reviewed and approved by the Institutional Review Board at the University of Southern California.

Sample

Selection of Trails. The three selected trails were chosen from a list of over a thousand potential candidates, identified using a web-based search (e.g., www.americantrails.org) and discussion with representatives from the Rails to Trails Conservancy. Potential trails were also selected from the National Transportation Enhancements database, the Coalition for Recreational Trails database, and the National Recreation Trails database. Candidate trails that maximized a set of *a priori* selection criteria were further considered for use in the study. These criteria included that the trails be available to multiple users, located within large metropolitan areas, a minimum of 15 miles in length, unbroken along their entire length, and located within different climatic regions. In addition, trails needed to traverse neighborhoods with at least two of the following racial or ethnic populations: African-American, European-American, and Hispanic. Each trail must have received some level of Intermodal Surface Transportation Efficiency Act (ISTEA) funding. When possible, trails were

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Figure 1

Chicago Lakefront Trail

Figure 2

Dallas White Rock Lake Trail

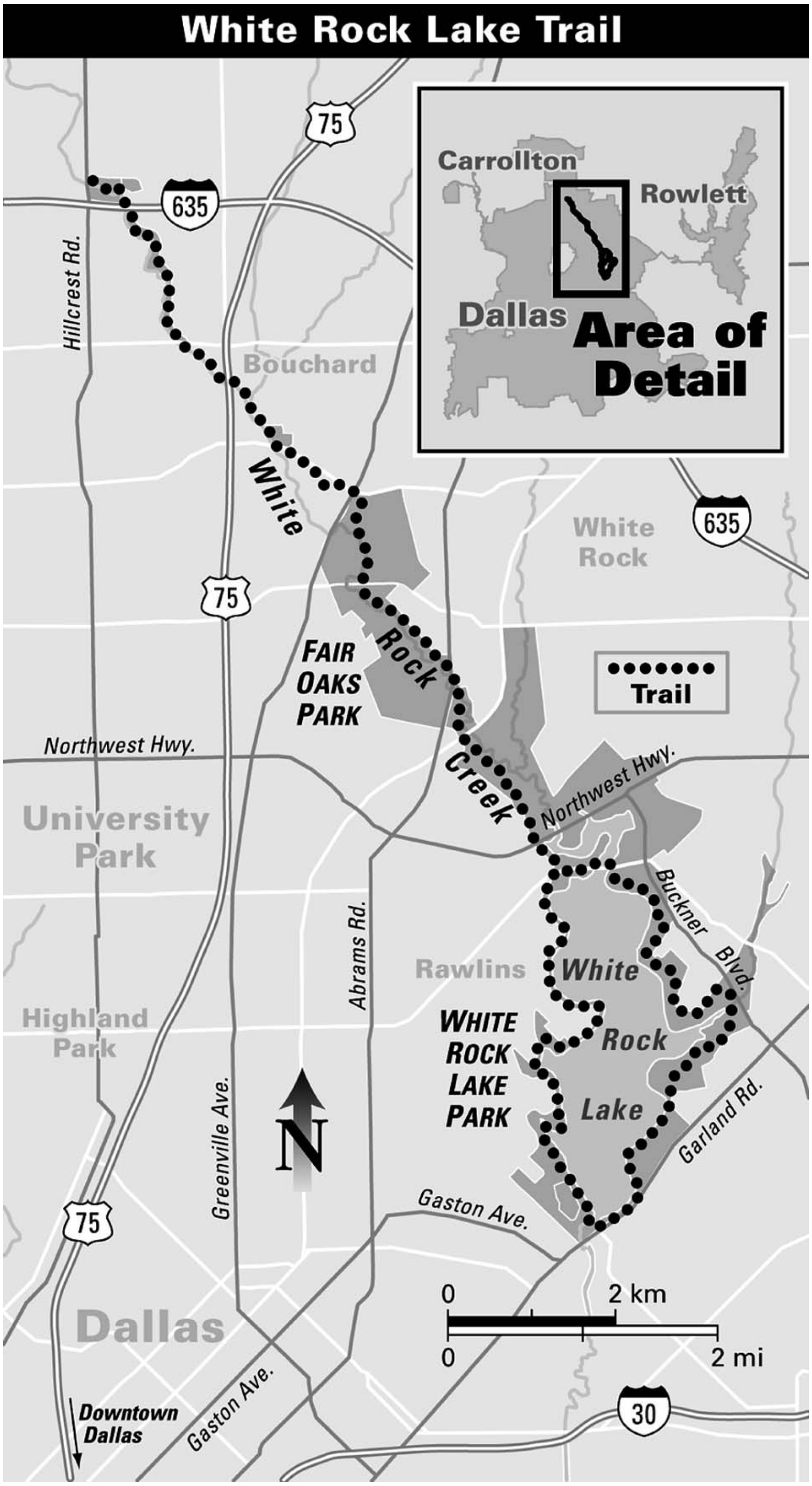

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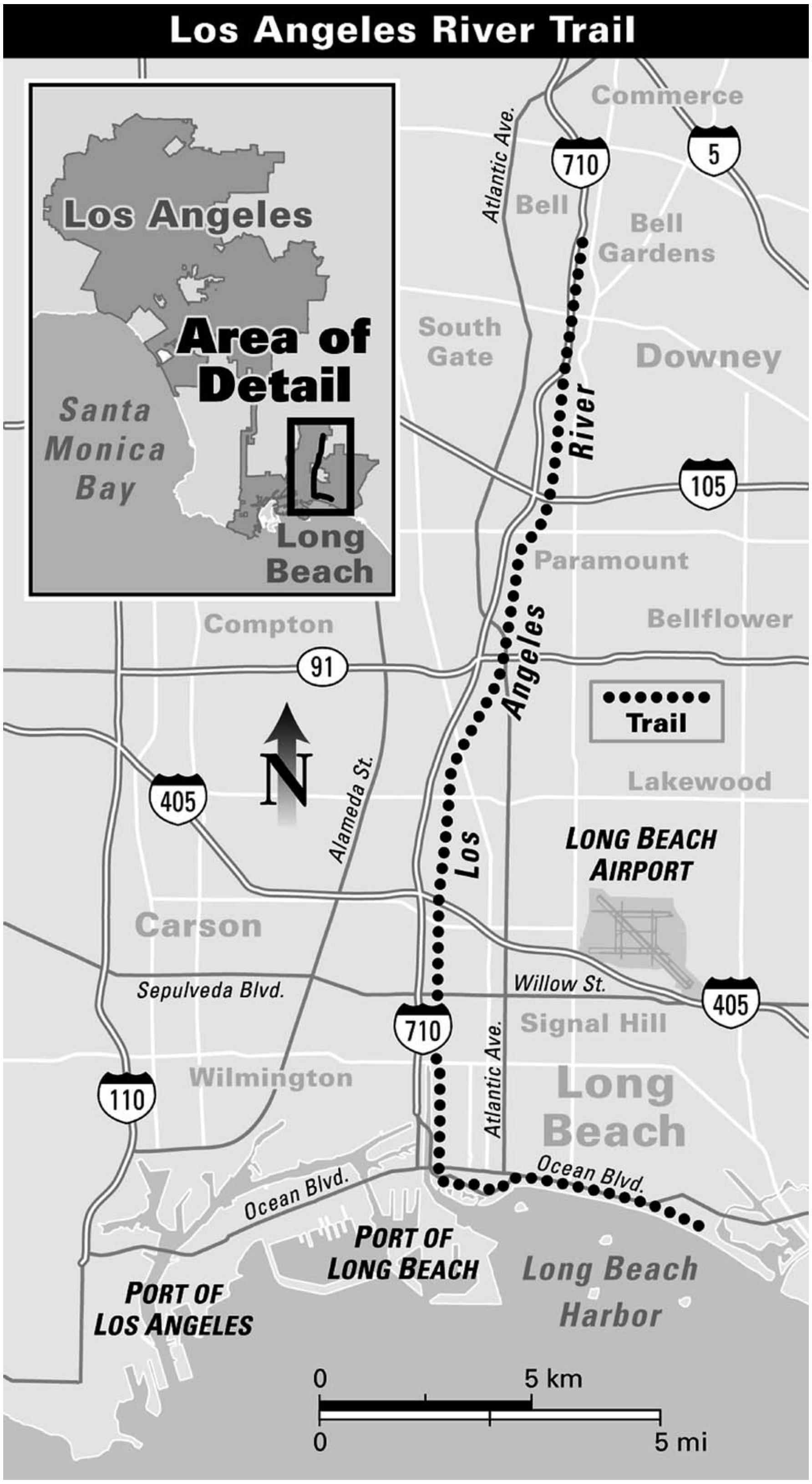
Figure 3

Los Angeles River Trail



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selected that were governed along their entire length by a single jurisdictional entity (e.g., city, county, park authority).

Sample for the Trail Count. For the trail count procedure, all trails users were observed and coded during the assessment period for a given trail segment. This procedure is described in detail below. We counted a total of 17,338 users on the trails—8931 in Chicago, 6715 in Dallas, and 2092 in Los Angeles. The majority of users were males (67%) and were between 18 and 39 years of age (56%), followed by users 40 to 64 (36%), under 18 (6%), and older than 65 years of age (2%).

Neither the trail audit nor the trail count procedure required the identification of individual users, and therefore, the IRB at the University of Southern California did not require the completion of a written informed consent by the individuals observed on each trail.

Measures

SPACES for Trails Instrument. After a careful review of the instruments available, it was decided that the Systematic Pedestrian and Cyclist Environmental Scan (SPACES) measure, developed by Pikora and colleagues, offered the best format for the creation of a trail audit instrument.[32] SPACES was designed for assessing the built environmental characteristics of city streets that promote walking and cycling.

Pikora and colleagues designed an environmental audit instrument that empirically assessed four main environmental factors, including functionality (e.g., slope, surface materials), safety (e.g., freedom from crime, separation from traffic), aesthetics (e.g., absence of litter), and access to facilities (e.g., parks, shops). Further, the instrument was divided into three parts. The first section comprised 10 questions assessing the characteristics of the environment adjacent to the streets (e.g., buildings, natural features, cycle paths). The second section comprised 25 questions that assessed the characteristics of streets (e.g., slope, curbs and traffic management, lighting, litter) and included a subjective assessment of the difficulty for cycling and walking. The third and final section consisted of two questions providing an overall assessment of legibility and continuity of the pedestrian and cycle paths. Reliability testing demonstrated that three of four raters agreed on the rating assigned for 66 of 67 items across the road segments assessed. In addition, 46 of the 67 items attained a kappa agreement statistic of 0.4 or higher.[32]

We adapted SPACES to U.S. cities, and to multiuse urban trails, by comparing the features assessed by SPACES with those present in the Los Angeles urban landscape. This adaptation has been described in detail elsewhere. [33] A panel of experts identified the areas of the instrument to be modified and provided suggestions about appropriate additional variables to assess. Several key elements of SPACES such as vegetation cover, vegetation density, and segment aesthetics were redesigned, and new items pertinent specifically to urban trails were added. A protocol with detailed definitions and supporting photographs for all items to be assessed was developed to supplement the instrument, based initially on the Los Angeles built environment but later updated with photographs from Chicago and Dallas. The new instrument was field-tested over several days on the San Gabriel River Trail in the Los Angeles area.

SPACES for Trails was divided into several components. Part A covered the trail environs and consisted of four questions pertaining to buildings and infrastructure, trailside facilities, and natural features found along the trail. Part B of the instrument consisted of 12 questions on trail functionality, including trail construction material, condition of the trail, slope, demarcation of the trail, obstructions, road crossings, and bicycle storage facilities. The third section of the instrument, part C, comprised 13 questions addressing trail safety. Questions in this section addressed the presence of streetlights, density of adjoining vegetation, visibility of adjoining properties, ease of seeing oncoming traffic along the trail, maintenance, litter, and crowding. Part D of the audit contained twelve questions pertaining to trail attractiveness. Questions in that section addressed noise, odor, views and general attractiveness, and difficulty for walking, cycling, dog-walking, and horse-riding. Part E comprised two questions addressing trail continuity and way-finding. Three response options were used, including a yes/no response, selection of a single category from a predefined list of options, and selection of multiple categories from a predefined options list.

Creation and Marking of Trail Segments. Completion of the trail audit using SPACES for Trails began with the delineation of trail segments and the marking of the trail in the field. The three trails were divided into half-mile-long segments using a Geographic Information System (GIS), ArcGIS 8.0 (ESRI, Redlands, California). Two maps were created for each segment, one with street names and one with aerial photography of surrounding areas. The trail was superimposed on each map. Each map covered a separate segment, and latitude and longitude coordinates for the start and end points of the segments were provided on the map. Prior to initiation of the audit, the trails were marked by one of the assessors using red flags and blue masking tape at the beginning of each segment. The segment number was clearly recoded on both the flags and the tape. Coordinates generated using the GIS were ''ground-truthed'' using a hand-held GPS (global positioning system). Flags and tape were replaced as necessary, due to loss from maintenance crews on ride-on mowers, overenthusiastic volunteers on a trail clean-up day that coincided with our research, and curious trail users looking for a souvenir.

SPACES Data Collection Procedure. Two assessors walked the entire length of the three study trails, with each assessor completing the full audit for each segment of each trail. A total of 50 miles (80 km) of trail was audited during the study, composed of 102 separate half-mile segments. The assessors began data collection at segment 1 on each trail and proceeded in ascending, sequential order, covering all trail segments. The trails in Chicago and Dallas took two days to complete; the trail in Los Angeles, which was slightly longer, took three days. Observations were recorded on paper forms, with a new form being used for each segment. The date, time, assessor's name, trail name, and trail segment number were also recorded on the first page of each form, and time, initial, trail name, and segment number on every page of all the forms. The interrater reliability of all items on the audit for every segment was determined using the kappa statistic. These analyses were conducted using the Chicago and Dallas data. Kappas of .40 or higher were obtained on 96 of 104 ratings, and of less than .40 on 8 of 104 ratings.

Trail Count Instrument. We collected data on the sex and age of trail users and the types of activities undertaken on the trails using a paper and pencil instrument in the field. The age of the trail users was estimated and recorded in one of four age brackets, including under 18 years, 18 to 39 years, 40 to 64 years, and over 65 years. Trail use activities were assigned to one of 10 categories, including cyclists, joggers/runners, walkers, skaters (in-line skaters and skateboarders), walkers with pets, equestrians, commuters (users going to or from place of work), photographers, wildlife viewers (e.g., bird watchers), and other. Agreements between data collectors indicated 67%, 90%, and 94% for age, gender, and type of use respectively.

Trail Count Procedure. Trail counters bicycled to the predetermined segment boundaries. Counters collected data at the beginning of each segment, counting users that passed by the trail markers for a period of 15 minutes. On those occasions when markers were removed by maintenance crews or trails users, the location of the segment boundary was verified using GPS coordinates, maps and aerial photographs, and descriptions of the location where the segment boundary was located. Counts were then completed, and boundary markers were replaced the following day.

Nine people participated in data collection. Trail counts took five days per trail. On the first day, one member set up the trail by verifying segments and marking them as previously described. At the same time, two pairs of trail counters walked the trail to familiarize themselves with each segment point. Counts on all trails were taken on two weekdays and two weekend days and were performed between 8 A.M. and 5 P.M. to enable comparison of trail use across different times of the day and across days of the week.

Analyses

Spearman's rho correlation coefficients were conducted in SAS (version 9). Poisson regression was also conducted in SAS (version 9.0) with the GENMOD procedure. SPACES variables with $\geq 95\%$ of the responses falling into a single rating category were eliminated from the analysis. Sixty-five SPACES variables were then categorized into eight qualitative categories including Aesthetics, Continuity and Navigation, Ease and Attractiveness of Use, Safety, Trail Adjacent Characteristics, Trail Characteristics, Trail Obstacles, and Trail Services. Each of the 65 SPACES variables were then regressed separately on the count of total number of trail users for the 102 trail segments examined. Development of a final model then proceeded using those SPACES variables significantly associated with the trail count outcome variable in the univariate regressions. The final model selection process started with inclusion of the most significant independent variable from each qualitative category based on the univariate regression analyses. Those variables not significant in the first multivariate regression run were dropped and replaced by variables with the second strongest association in each qualitative category, based on the univariate analyses, and the multivariate model was run with the new variables. This procedure iterated until all independent variables in the model were significant. Significance was set *a priori* at $p < .05$. Population density was included as a covariate in all multivariate models.

The Poisson model used in the analysis can be described as follows:

For count data y taking integer values 0, 1, 2, 3, …

$$E[y_i|x_i] = \lambda_i = \exp(\beta_1 + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})$$

Or:

$$\ln \lambda_i = \beta_1 + \beta_2 x_{2i} + \ldots + \beta_k x_{ki}$$

Table 1

Percentage Trail Use by Sex, Age, and Type of Use*

	All Trails	Chicago	Dallas	Los Angeles
Males	67%	62%	72%	71%
By age:				
Under 18	6%	6%	3%	12%
18–39	56%	64%	48%	45%
40–64	36%	29%	46%	37%
65+	2%	1%	2%	7%
Type of use:				
Cyclists	67%	60%	79%	60%
Joggers	14%	18%	10%	10%
Walkers	13%	15%	8%	20%
Skaters	5%	6%	2%	8%
Others	1%	1%	1%	2%

* Column percentages for age and type of use may not sum to 100% due to rounding error.

where λ is the mean number of occurrences.

Coefficients in the Poisson model used can be interpreted in the following fashion: One unit change in X_k leads to a proportionate change of $e^{\beta k}$ in λ.

RESULTS

Trail Use

Trail use across the three trails has been described in detail elsewhere.[34] A brief summary of the observed trail use is provided in the present manuscript. A total of 17,738 individuals were counted using the three trails (Chicago, n = 8931; Dallas, n = 6715; Los Angeles, n = 2092). Users were 67% male (Chicago, 62%; Dallas, 72%; Los Angeles, 71%). Use by age and travel mode is shown in Table 1. Counts include only those people engaging in activities on the trail. People in places adjacent to the trail (e.g., restaurants, playgrounds, beaches) were not counted.

Correlates of Urban Trail Use

A correlation matrix is presented in Table 2. Correlation coefficients ranged from small to large for associations with the trail use outcome variable and from small to medium among the SPACES for Trails variables.

Health Promotion hepr-21-00-09.3d 12/1/07 10:21:00 341 Cust # 06052576R

Table 2

Correlation Matrix (Spearman's Rho) of the Systematic Pedestrian and Cycling Environmental Scan for Trails (SPACES for Trails) Variables and the Trail Use Outcome Variable

	Litter	Trail Noise Present	Type of View (Mixed vs Natural)	Vegetation Density	Street-lights Present	Trail Condition	Drainage Canal as a Predominant Feature	Count of Natural Features
Trail use	−0.13	−0.23*	0.16	0.24*	0.47***	−0.19	−0.71***	−0.31**
Litter present on trail		−0.01	−0.22*	0.08	−0.10	−0.05	−0.05	0.06
Trail noise present			0.28*	−0.05	0.10	0.17	0.34***	−0.08
Type of view (mixed vs. natural)				−0.33**	0.24*	0.02	0.20	−0.14
Vegetation density					0.09	−0.08	−0.37***	0.21*
Streetlights present						0.06	−0.32***	−0.24*
Trail condition							0.24*	0.24*
Drainage canal as a predominant feature								0.01
Count of natural features								
Tunnel present								
Café present								

*$p < .05$, **$p < .01$, ***$p < .001$.

Correlates from all qualitative categories except continuity and navigation were significantly associated with the trail count outcome variable. From the aesthetics category, the presence of litter and noise on the trail were inversely associated with use (Table 3). From the ease and attractiveness category, the presence of mixed views was positively associated with trail use compared to the presence of a natural view. Two variables from the safety category were related to trail use, including a negative association for vegetation density and a positive association for the presence of streetlights. Trail-adjacent characteristics associated with trail use included inverse associations for the presence of drains and natural features next to the trail. The condition of the trail surface, from the trail characteristics category, was associated such that the better the condition of the trail, the greater the trail use. The presence of tunnels from the trail obstacles category was negatively associated with trail use. For the trail

Table 3

Poisson Regression of SPACES for Trails Variables on Trail Use Controlling for Population Density and City

Parameter	Estimate	Wald 95% Confidence Limits		$p <$	Percent Difference in Trail Use*
Litter present on trail	−0.22	−0.31	−0.13	.0001	−20
Trail noise present	−0.41	−0.52	−0.29	.0001	−33
Type of view: mixed vs. natural	0.33	0.20	0.45	.0001	39
Vegetation density	−0.10	−0.16	−0.04	.001	−9 (Dense vs. Medium) −18 (Dense vs. Light) −25 (Dense vs. None)
Streetlights present	0.30	0.20	0.40	.0001	35
Trail condition	0.28	0.19	0.36	.0001	32 (Excellent vs. Fair) 73 (Excellent vs. Poor)
Drainage canal as predominant feature	−0.67	−1.04	−0.31	.0003	−49
Count of natural features	−0.39	−0.47	−0.31	.0001	−32 (per increase of 1 in natural features)
Tunnel present	−0.20	−0.39	−0.01	.04	−18
Café present	0.38	0.27	0.48	.0001	46
Count of trailside facilities	0.08	0.04	0.12	.0001	8 (per increase of 1 in trailside facilities)
Population density	0.02	0.01	0.02	.0001	2 (per increase of 1 in population density)
Dallas	1.17	0.92	1.43	.0001	224
Chicago	0.85	0.63	1.07	.0001	134

* Percent difference based on a one-unit change in the independent variable. Independent variables are binary except as noted here. Vegetation density ranges from 1 to 4, 1 as no vegetation and 4 as dense vegetation; trail condition ranges from 1 to 3, 1 as poor and 3 as excellent; natural feature count ranges from 0 to 3; trailside facility count ranges from 0 to 4; and population density ranges from 1.35 to 64.63.

Health Promotion hepr-21-00-09.3d 12/1/07 10:21:01 342 Cust # 06052576R

Table 2

Extended

Tunnel Present	Café Present	Count of Trailside Facilities
−0.51***	0.33***	0.50***
−0.03	0.04	0.05
0.11	0.07	−0.14
−0.08	0.00	0.20
−0.07	−0.08	0.06
−0.26**	0.17	0.14
0.26**	0.06	−0.19
0.40***	−0.20*	−0.48***
0.24*	−0.15	−0.07
	−0.15	−0.47***
		0.36***

services category, the greater the number of services adjacent to the trail, the greater was the rate of use.

In order to estimate the strength of the association for each correlate, we estimated the percentage increase or decrease in trail use that can be attributed to each correlate in the final model, controlling for all other correlates. This is presented in Table 3 and suggests that trail condition (poor vs. excellent) accounts for the greatest change in use of a trail segment, while an increase from medium to dense vegetation accounts for the least.

DISCUSSION

Results indicate that levels of trail utilization are related to several characteristics of built and natural trail environments after controlling for population density in buffer areas adjacent to the trails and for city location. These findings, particularly if confirmed by additional studies, can help guide public policy decisions about urban trail infrastructure investments and in turn may support and increase levels of physical activity. The trail environment variables were organized according to eight qualitative categories aiding in the analysis and interpretation of the findings. Aesthetics, Ease and Attractiveness of Use, Safety, Trail Adjacent Characteristics, Trail Characteristics, Trail Obstacles, and Trail Services all contributed correlates to the final model, while Continuity and Ease of Navigation failed to do so.

Findings for the aesthetics variables of litter and noise suggest that eliminating factors that reduce the attractiveness of the trail may be a critical component in increasing trail use. Litter can be cleaned up through the efforts of trail governing authorities and perhaps through the involvement of community groups and associations of trail users. Noise is more intractable, since it is typically introduced by major roadways that run near the trails. In siting new trails, the governing authorities (e.g., city governments, planners, parks and recreation personnel) should consider distance to major roadways and other consistent sources of noise when determining routes. When close proximity is unavoidable, trail authorities should consider incorporating sound attenuation features (e.g., sound walls, landscaped berms, white noise features such as waterfalls and fountains), collaborating with other agencies (e.g., transportation authorities) as needed. Vegetation buffers may be used to improve trail users' perceptions of ambient noise or to soften the appearance of noise barriers. To the extent possible, noise barriers or buffers should not eliminate visibility of the trail from surrounding properties, in order to limit safety concerns noted later in this discussion. We recognize that the inclusion of these noise-dampening features will be expensive and may not be possible on all trails or on all portions of a given trail. The finding that segments running through areas with mixed views (both urban and natural views present on the same segment) were more likely to be used than segments running through areas with only natural views also warrants consideration in routing decisions. This finding is somewhat inconsistent with earlier work showing that a major perceived value of urban greenway trails for community quality of life is the preservation of natural areas.[23] Greater trail use on segments with mixed views may indicate an aesthetic preference among urban trail users for a mix of natural and urban features in trailside scenery. In addition, segments that have both urban and natural elements may provide a greater number of access points to the trail and thereby facilitate trail use. Finally, it may be possible that the presence of mixed views covaries with greater land use mix, enhancing access to areas of the city where recreational opportunities and services can be found and increasing trail use as a result.

Two factors emerged that were included in the safety qualitative category: vegetation density and the presence of streetlights. Streetlights were positively associated with trail use and may facilitate safety both in terms of reducing crime and in preventing accidents and collisions on the trail. It is interesting to note that this relationship was identified even though the trail counts were conducted during the day. Several explanations may account for this association. One is that the streetlights are seen and create the perception of a well-ordered and safe trail environment during the day as well as at night. A second is that streetlights co-occur with other variables that account for the increased use of those trail segments. That is, streetlights are merely an indicator of a very well designed trail segment. Finally, the causal direction may be reversed, with streetlights being placed in segments where people are most often using the trail. As vegetation density increased, trail use decreased. This was seen as a safety factor. Heavier vegetation provides cover for individuals who may be interested in confronting trail users and at the same time makes it harder for witnesses who might provide help to see such events and intervene. In addition, dense vegetation may make it harder to see oncoming traffic and increase the risk for accidents on the trail. The finding on vegetation density is also important given its hypothesized relationship to attractiveness. That is, trails with more dense vegetation might be seen by many as being more attractive, potentially facilitating trail use. However, the present findings suggest that the diminished perceptions of safety resulting from heavier vegetation density outweigh any benefits accrued from enhanced trail attractiveness.

An increase in trailside facilities, and particularly the presence of cafés, was

Health Promotion hepr-21-00-09.3d 12/1/07 10:21:02 343 Cust # 06052576R

positively associated with trail use. This is consistent with prior work on environmental predictors of physical activity in communities and when related to trail use.[14,35,36] Private sector facilities such as restaurants, coffee bars, or cafeterias may be difficult to attract to trailside areas or may require public-private partnerships. However other amenities, such as benches and bicycle racks, may be relatively inexpensive and easy to provide for trail users.

An increase in the number of natural features on the trail was related to lower levels of trail use. In our estimation, this was counterintuitive, the expectation being that segments with more natural features would be seen as more attractive and thus used more often. In support of this notion, prior work has shown a positive association between aesthetics and increased physical activity.[14,37] However, the observed inverse association may reflect some of the same issues noted above for mixed views; that is, segments with more natural features may have less trail access, may be preferred less as an aesthetic quality by urban trail users, and may provide less access to urban resources. In addition, an increase in lakes, canyons, and hillsides further isolates trail users and increases their sense of vulnerability. The effect for drainage as a predominant natural feature is the result of coding the Los Angeles River as a predominant built trailside feature. Given the fact that the course of the Los Angeles River is now entirely channelized and lined with concrete, in effect having been transformed into a flood control channel, this recoding is warranted. The inverse association indicates that trail users are less likely to use a trail segment where a large built drainage feature predominates. However, the segments of the Los Angeles River trail that parallel the channel are also those segments with the lowest socioeconomic status level for trailside neighborhood residents. Therefore, in these analyses, the presence of the Los Angeles River drainage may be confounded with socioeconomic status.

Continuity and Ease of Navigation was the only category of variables not associated with trail use. Several reasons might explain these null effects. First, the trails are easy to follow on segments where side routes are limited or reconnect to the main trail within a short distance. Second, where the trail was difficult to follow, this confusion could be readily resolved; repeat users would have no further difficulty. As a result, confusion about the correct path in a given segment is apt to be short-lived, and repeat trail use would not be inhibited by any confusion about how to navigate the trail.

Several limitations are present in this research. First, caution must be used when interpreting these results and translating the findings into recommendations for policy change. The design used to identify and test these correlates does not allow for the determination of causal direction: the correlates may cause levels of trail use or they themselves may be caused by trail use. An example of the latter might be provided by the finding that the presence of cafés on the trail is related to higher trail use. It is difficult to know whether trail users come to this segment because a café is present, or if a café was built on this segment because a large number of users were already present. For some relationships, one causal direction may be more plausible than another, although this cannot be firmly established with the present design. For example, trail noise, typically from large traffic arteries near the trail, may cause reduced levels of use on the noisy segments. It is less plausible that large and noisy arterial roadways were built because trail use was high on a particular segment. The second limitation involves the time of day that trail counting occurred. Due to resource limitations, we could not conduct trail counts from sunup until sundown on each day of data collection. To ensure comparability across days and across trails, data collection began in the morning and continued into the afternoon. Evening counts (after 5 P.M.) could not be conducted, and results cannot readily be generalized to trail use occurring during this time period. Individuals who use trails in the morning may engage in higher-intensity physical activity, leading to an oversampling of more physically fit individuals in the trail count.[38] Third, there may be some variation in trail use between trails that can be attributed to temperature and seasonality effects.[28] We attempted to conduct the assessments in each city when temperatures would be warm and conducive to trail use. This was largely accomplished, but some variations were observed in mean daytime temperature across sites.

The analyses presented in this manuscript used trail counts aggregating across all types of use, both genders, and all ages. However, the pattern of correlates may in fact vary by type of use, gender and age. For example, the condition of the trail surface may be more critical for cyclists, while issues of vegetation density may be more critical to walkers, and the provision of trailside services may be equally important for both types of users. Thus, an

SO WHAT? Implications for practitioners and researchers

Positive associations with trail use were observed for mixed and urban views, streetlights, good trail condition, and the presence of trailside amenities. Negative associations were observed for litter, noise, higher vegetation density, drainage features, tunnel present, and natural areas adjacent to the trail. The coherent picture that emerges from these findings is that trails designed with the issues of visibility and safety in mind and with trailside services and amenities available will be used more heavily. Practitioners, including city planners, politicians, and trail use advocacy groups, should consider these factors in the design of new urban trails (e.g., routing, inclusion of trailside amenities) so that the public investment encourages use. These findings also suggest that programming resources for maintenance of existing trails (e.g., litter cleanup and landscape maintenance services) is necessary not only to protect the substantial financial investment of public funds but to ensure that people will continue to use the facilities. For researchers, attempts to establish the causal direction of these relationships, to replicate the associations with activity observed at all time points during the day, and to explore the presence of overarching safety concerns are warranted.

Health Promotion hepr-21-00-09.3d 12/1/07 10:21:02 344 Cust # 06052576R

examination of the pattern of correlates across type of use, gender, and age is warranted. Future research might also consider (1) the confirmation of the model using a split sample, bootstrapping techniques, or the use of a new sample, and (2) the importation and use of variables from Geographic Information Systems to further identify correlates of trail use from characteristics of the environment immediately adjacent to the trail. For example, the land use mix and the socio-demographic status of residents surrounding each trail segment can be better achieved through the use of GIS strategies.

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