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Trails and Physical Activity: A Review

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Purpose: To provide a synthesis of research on trails and physical activity from the public health, leisure sciences, urban planning, and transportation literatures. ***Methods:*** A search of databases was conducted to identify studies published between 1980 and 2008. ***Results:*** 52 studies were identified. The majority were cross-sectional (92%) and published after 1999 (77%). The evidence for the effects of trails on physical activity was mixed among 3 intervention and 5 correlational studies. Correlates of trail use were examined in 13 studies. Several demographic (eg, race, education, income) and environmental factors (eg, land-use mix and distance to trail) were related to trail use. Evidence from 31 descriptive studies identified several facilitators and barriers to trail use. Economic studies (n = 5) examining trails in terms of health or recreational outcomes found trails are cost-effective and produce significant economic benefits. ***Conclusion:*** There is a growing body of evidence demonstrating important factors that should be considered in promoting trail use, yet the evidence for positive effects of trails on physical activity is limited. Further research is needed to evaluate the effects of trails on physical activity. In addition, trail studies that include children and youth, older adults, and racial and ethnic minorities are a research priority.

Keywords: exercise, environment

The health benefits associated with regular physical activity include reduced risks of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon cancer, breast cancer, and depression.[1] Despite this evidence, recent surveillance estimates based on objective assessments with a nationally-representative sample of U.S. adults indicate that less than 5% of the population meet physical activity recommendations.[2] Moreover, the effective promotion of physical activity at the population level continues to be a challenge for public health practitioners and researchers with growing recognition that individual and interpersonal strategies alone are insufficient at producing sustained increases in physical activity.[3,4] A recent systematic review of physical activity interventions conducted by the U.S. Taskforce on Community Preventive Services found sufficient evidence to recommend 3 policy and environmental approaches to promote physical activity.[3,4] These included 1) the creation of or enhanced access to community facilities combined with informational outreach, 2) community-scale urban design and land-use policies and practices to increase physical activity (eg, zoning regulations, transit-oriented development, density of development, and the location of stores, jobs and schools within walking distance of residences), and 3) street-scale urban design and land use policies (eg, street lighting, sidewalks, traffic calming, and enhanced aesthetics of the street area). The development of trails within communities and the promotion of their use for physical activity fit well with the Taskforce recommendations. The premise is that trails that are embedded in communities can provide opportunities for engaging in physical activity proximal to where people live and work. While interest in trails grows among those in the public health sector, there is a growing focus on trails among those involved in the parks and recreation, transportation, and planning sectors. This increased awareness of the potential for using trails to promote physical activity or quality of life is also evident by the increasing amount of trail construction projects. For example, the Rails-to-Trails Conservancy, a nonprofit organization that works with communities to transform abandoned railroad right-of-ways into community rail-trails, reports there are more than 15,000 miles of rail-trails and more than 100 million annual users.[5]

Since 2001, several literature reviews on the associations between the built environment and physical activity and obesity, and 1 on parks and recreation settings and physical activity, have appeared in the public health and transportation literatures.[6–11] However, to our knowledge, no review has exclusively focused on trails. Given the potential of trails to serve as a significant environmental resource for physical activity promotion, a review of the current evidence base on trails seems warranted and timely. The purpose of this review is to provide a comprehensive qualitative synthesis of published research on trail use and physical activity from the public health,

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parks and leisure sciences, urban planning, and transportation literatures. A primary research question of interest is whether trails (eg, presence of existing trails, new trail construction, or trail promotion campaigns) have positive effects on physical activity. A related objective is to identify current gaps in the evidence base and provide recommendations for future research.

Methods

The protocol for conducting this literature review was similar to the PRISMA[12] guidelines for conducting systematic reviews in that 1) individual studies making up the body of the evidence were identified; 2) information was extracted; 3) study design, methods, and results were evaluated by 2 independent reviewers and 2 senior reviewers reconciled any differences; and 4) the overall body of evidence was summarized. To address the question of whether trails have positive effects on physical activity additional methods included an assessment of study design and quality of study execution and a conclusion about the overall strength of the evidence, similar to methods developed by the Task Force on Community Preventive Services for evaluating intervention research.[13,14]

A comprehensive search was conducted of peer-reviewed studies on community trails and physical activity published between January 1980 and December 2008. Study inclusion criteria were as follows: 1) trail(s) under study were imbedded in communities, 2) study was published in a peer-reviewed English-language journal, 3) study involved primary quantitative data collection or secondary analyses of quantitative data, and 4) study focus was related to either understanding or increasing trail use, or related to physical activity and health promotion. Qualitative studies, literature reviews, nonpeer reviewed articles, studies on trails within national parks or forests, and studies not specific to trails (eg, with a broader focus on the built environment) were excluded.

To identify studies in a range of disciplines, several databases were searched in health (eg, PubMed and Health Source: Nursing/Academic Edition), social sciences (eg, PsycINFO and Social Science Abstracts), parks, recreation, and leisure science (eg, CAB Abstracts and Sport Discus), transportation (eg, Transport), urban planning (eg, EI Engineering Village2), and architecture/landscape architecture (eg, Agricultural and Environmental Biotechnology Abstracts and Biological & Agricultural Index Plus). Search terms included combinations of the following keywords: trails, paths, health, walking, physical activity, exercise, public health, community, environment, geographic information systems, multiuse trail, and rail-trail. The database searches resulted in 1135 article citations. After deleting duplicates, and then sequentially reviewing the article title, abstract, and manuscript for appropriateness, 36 articles were identified for review. Reference lists at the end of these articles were also examined, which led to the identification of 16 additional articles, for a total of 52.

Key features of the 52 studies were independently extracted into a database by 2 reviewers. Features included study design (eg, cross-sectional, quasi-experimental), primary aims, location/setting and trail characteristics, sampling, sample characteristics, key measures, and the main findings. The reviewers then compared the extracted information to arrive at a consensus about the classification of study components.

To address the research question about the effects of trails on physical activity 8 of the 52 studies were further evaluated using methods developed by the Task Force.[6,7] These 8 studies were identified because they either examined the effects of trails on physical activity or examined associations between trails and physical activity. Each study was evaluated using a standardized abstraction form and assessed in terms of suitability of study design and 9 possible threats to validity.[7] Suitability of design was classified as least, moderate or greatest and the quality of execution was classified as limited, fair or good based on the number of threats to validity.[6] The overall strength of the evidence was then classified based on the number of studies, the suitability of design, quality of execution, effect sizes, and consistency across studies.

Results

As shown in Figure 1, the number of trail publications increased dramatically between 1980 and 2008. The greatest increase in publications was seen in the public health literature starting in 2000. Characteristics of the studies are shown in Table 1. Most studies were conducted in the United States (94%), were cross-sectional (92%), and only 3 studies (6%) used a prospective design.[8–10] The 52 studies were classified into 4 areas of research interest: 1) effects of trails and trail promotion on physical activity,[8–15] 2) correlates of trail use,[11,13,15–26] 3) facilitators and barriers of trail use,[12,14,27–55] and 4) economics of trails for promotion of physical activity and recreation.[36,56–59]

Effects of Trails and Trail Use Promotion on Physical Activity

Among the 52 studies included in this review, 8 studies evaluated the effect of trails or trail campaigns on physical activity.[8–15] The majority (n = 7) had the least suitable designs (eg, cross-sectional, single group pre/post test) and 1 had a moderately suitable design (eg, pre/posttest with comparison group).[10] Prospective studies (n = 3) evaluated the effects of new trails, trail campaigns or trail use on physical activity (see Table 2)[8–10] and correlational studies (n = 5) examined the associations of trails and trail use with physical activity (see Table 3).[11–15] All 8 studies were of fair execution and were used to evaluate the overall strength of the evidence on effects of trails on physical activity. A common threat to validity found among these studies was the potential for measurement and misclassification bias due to the use of instruments that had not been validated for measuring trail use,

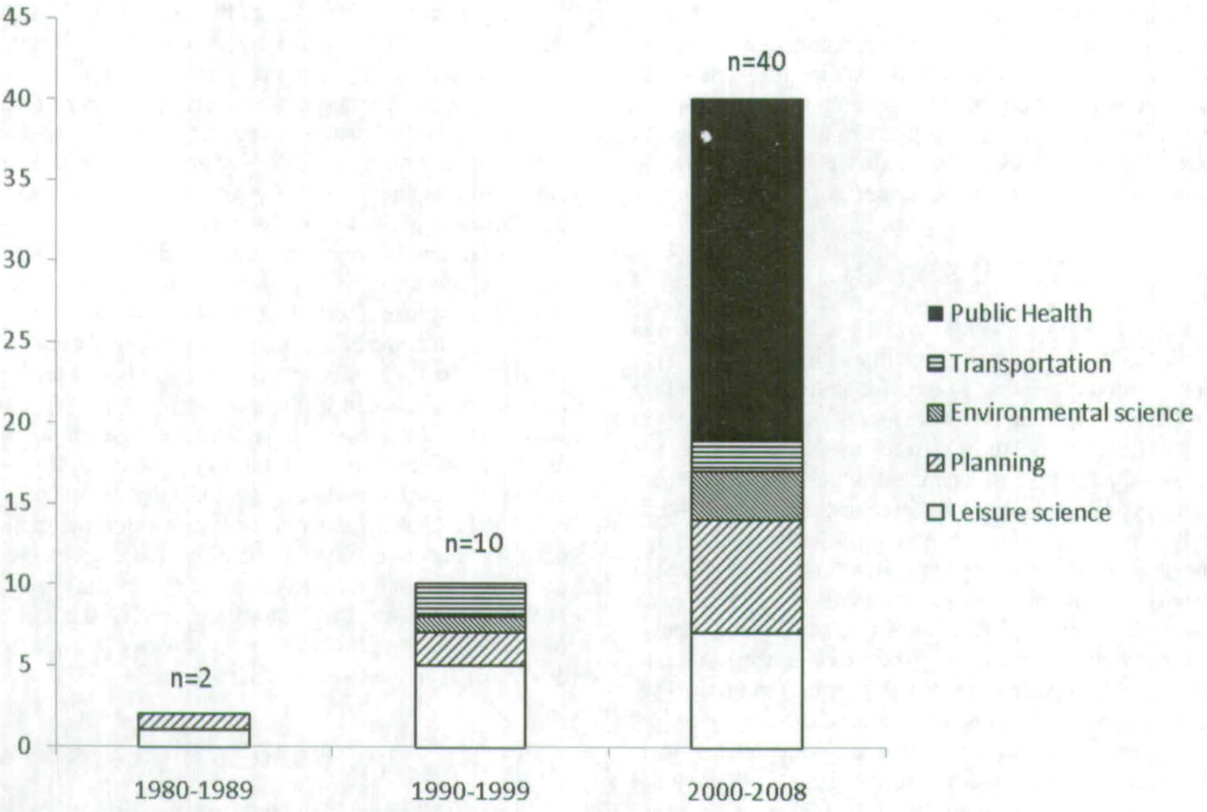

Figure 1 — Number of studies on trails and physical activity by decade and discipline (n = 52).

physical activity, or exposure to trails. Effectiveness measures varied across studies and included estimates of change or difference in levels of walking or other physical activities, and change or difference in percentage meeting physical activity recommendations. Overall the effects found in these studies were mixed (ie, positive, negative, and null effects). The body of evidence for the effects of trails on physical activity can be characterized as insufficient for at least 2 reasons: 1) lack of suitable study designs and 2) inconsistent effects. A brief summary of the 8 studies follows.

In Western Sydney, Australia, a 3-month mass media campaign to increase use of a newly constructed 16.5 km rail-trail did not have an overall positive effect on trail use or physical activity among residents living within 5 km of the trail.[8] A significant percentage of those who lived close to the trail (12%) reduced their activity and became insufficiently active at campaign follow-up. However, those that lived within 1.5 km of the trail did increase their mean cycling time from 17 to 28 minutes, while those who lived 1.5 to 5 km from the trail decreased their cycling time from 45 to 31 minutes. These changes were significantly different between the 2 groups.

In Durham, North Carolina, no significant increases in physical activity or walking for transportation were found 2 months after the construction of a 5-mile rail-trail.[9] However, 23% of trail users reported that they had increased their physical activity since they began using the trail. Trail users compared with nonusers had a greater odds of decreasing time spent bicycling for leisure and a lower odds of increasing time in leisure walking.

In 6 rural communities in southeast Missouri, a multistrategy community-based physical activity campaign included individually-tailored informational materials, activities to encourage social support, and community-wide events to promote walking and the use of recently constructed trails.[10] The trails were mostly walking paths in city parks, primarily asphalt or gravel, and ranged in length from 0.1 to 2.4 miles. No significant intervention effects on walking were found when intervention communities were compared with communities in Arkansas and Tennessee. Despite this finding, 32% of surveyed participants in the intervention communities retrospectively reported increasing their physical activity since they began using a local trail. In a related cross-sectional study in southeast Missouri, 55% of trail users retrospectively reported they spent more time walking since they began using their local trail.[11]

In the Twin Cities area of Minnesota, distance from the home to trails was not correlated with bicycling for transportation.[12] However, in Arlington, Massachusetts living an additional 1/4 mile further from a rail-trail was associated with 55 fewer minutes per week of transportation-related walking or bicycling.[15] Similarly, among

Table 1 Study and Sample Characteristics of Trail Studies Published Between 1980 and 2008 (n = 52)

	n (%)	References
Design		
Descriptive[a]	31 (60%)	12,14,27–55
Correlational	13 (25%)	11,13,15–26
Economic evaluation	5 (10%)	36,56–59
Prospective evaluation	3 (6%)	8–10
Sampling frame		
Trail users[b]	33 (63%)	17–22,25,28–32,34–44,46,48–52,56–58
Community members	19 (37%)	8–16,23,24,26,27,33,45,47,53–55
Sample characteristics		
Age[c]		
Did not report	18 (35%)	12,17,19,20,30,31,33,35,38,41,43,44,48,50,54,57–59
Mean age < 40 yrs	10 (19%)	16,18,24,25,29,32,46,47,49,51
Mean age 40–49 yrs	16 (31%)	8,13,21–23,27,28,36,37,39,40,42,45,52,53,56
Mean age ≥ 50 yrs	8 (15%)	9–11,14,15,26,34,55
Gender		
Did not report	21 (40%)	17,19,21,22,30,31,33,35–38,41,43,44,48–50,54,57–59
25–48% female	8 (15%)	20,25,28,34,39,40,46,52
50–76% female	23 (44%)	8–16,18,23,24,26,27,29,32,42,45,47,51,53,55,56
Race/ethnicity		
Did not report	25 (48%)	8,12,17,21,22,25,27–31,34–38,41,43,44,47,48,54,56–58
<15% non-White minority	12 (23%)	11,15,16,18,26,32,39,40,42,52,53,55
>19% non-White minority	14 (27%)	9,10,13,14,19,20,23,24,33,45,46,50,51,59
All Latino	1 (2%)	49
Education level		
Did not report	23 (44%)	17,20,21,25,30,31,35–38,41,43,44,46,48,49,51,53,54,56–59
56–70% less than college education	4 (8%)	8,11,19,50
>50% college education or more	25 (48%)	9,10,12–16,18,22–24,26–29,32–34,39,40,42,45,47,52,55
Country		
United States	49 (94%)	9–36,39–59
Australia	2 (4%)	8,37
New Zealand	1 (2%)	38
Urban, suburban, or rural setting		
Did not report	29 (56%)	8,9,13,14,16–18,21,22,24,27–29,31,34,36–38,40,42,43,45,47,51–53,56–58
Urban	16 (31%)	12,19,20,23,25,30,32,33,41,44,46,48–50,54,59
Suburban	5 (10%)	15,26,35,39,55
Rural	2 (4%)	10,11
Trail function		
Multiuse trail	43 (84%)	8,9,13,16,18–23,25,26,28–44,46,47,49–59
Walking trail	4 (8%)	10,11,14,45
Bicycling trail	2 (4%)	12,48
Nonspecific	3 (6%)	15,24,27
Method of measuring trail use or physical activity		
Intercept survey	22 (43%)	14,18,21,22,28–30,32,34–42,46,48,51,52,56
Telephone survey	11 (22%)	8–12,16,23,24,27,45,53
Direct observation	9 (18%)	17,25,31,32,46,49,56–58
Infrared traffic monitors	6 (12%)	19,20,43,44,50,51
Mail survey	5 (10%)	13,15,26,54,55
Online survey	1 (2%)	47
Multiple methods[d]	5 (10%)	32,46,51,56,59

[a] Descriptive studies that did not examine correlations or associations with trail use or physical activity. [b] Sampling from trail users includes sampling individual users and conducting audits or trail counts on sampled trail segments. [c] Two studies included youth <18 yrs of age.[18,37] [d] A combination of either infrared monitoring or direct observation and intercept surveys were conducted to assess trail use.

Table 2 Prospective Studies Examining the Effects of Trails and Trail Campaigns on Physical Activity (n = 3)

Reference	Design and sample	Intervention	Physical activity outcome(s)	Results
8	• One group pre/posttest • Randomly selected adult residents from within 1.5 km (inner) and between 1.5 and 5 km (outer) of new 16.5km trail	Media campaign to promote newly constructed trail	Self-reported walking and bicycling, sufficient activity levels, and observed bicycle counts on trail	• No significant effects on walking • Significantly fewer inner pedestrians were sufficiently active after the campaign (–12.4%). • Significant difference in bicycling duration between inner cyclists (+11.9 min) and outer cyclists (–14.3 min). •Significant increases in daily bicycle counts on trails.
9	• One group pre/posttest • Randomly selected adults living within 2 miles of new trail segment	Construction of a new rail-trail segment	Self-reported moderate and vigorous leisure activity, and walking and bicycling for transportation and leisure	• No significant effects on leisure activity or on walking for transportation when comparing trail users to nonusers. • 22.5% retrospectively reported that they had increased physical activity since first using the trail. • Trail users compared with nonusers were less likely (OR = 0.43) to increase leisure walking by at least 45 minutes per week from baseline. • Trail users compared with nonusers were more likely (OR = 3.99–4.17) to decrease leisure bicycling by 15-45 minutes per week from baseline.
10	• Two group pre/posttest • Randomly selected adults in 6 intervention communities and 6 comparison communities	Construction of walking trails, community campaigns comprised of newsletters, individual walking reports, walking clubs, and community events	Self-reported walking	• No significant effects on walking • 32.1% retrospectively reported that they had increased their physical activity since first using the trail.

Table 3 Cross-Sectional Studies Examining Associations Between Trails and Physical Activity (n = 5)

Reference	Sample	Physical activity outcome	Trail variable	Results
11	Residents in 12 rural counties of southeast Missouri (n = 1269)	Reported change in walking since first began using trail	Distance to trail, trail surface, trail length	• Distance to trail was not a significant correlate of walking. • 55.2% of trail users reported feeling they had increased time spent walking since first using the trail (retrospectively). • Longer trails (>1/4 mile & >1/2 mile) were associated with greater odds of reporting increased walking (OR = 2.8 and 13.2). • Chat trails (vs. asphalt trails) was associated with lower odds of reporting increased walking (OR = 0.3).
12	Residents in the Twin Cities area, Minnesota (n = 1653)	Bicycling for transportation at least once per day	Straight line distance from home to off-street bicycle path	• Distance to bicycle pathway was not associated with bicycling for transportation at least once per day.
13	U.S. national sample (n = 3717)	Sufficient physical activity	Weekly use of trails	• Using trails at least once a week was associated with greater odds of being regularly active (OR = 2.3).
14	Health clinic patients in Texas (n = 1211)	Walking ≥ 30 minutes at least once per week	Perceived proximity to a walking trail or bicycling path	• Perception of living close to a trail was associated with greater odds of walking >30 minutes at least once per week (OR = 1.5).
15	Residents in a suburban community near Boston, MA (n = 413)	Minutes of recreational and transportation physical activity	Objectively measured distance from home to trail	• Distance to trail was not associated with recreational physical activity. • Distance to trail was inversely associated with minutes of transportation physical activity ($\beta = -54.65$, $P = .05$)

adults using a community clinic in Texas, the perception that one lives close to a trail was associated with a 1.5 times greater odds of walking for at least 30 minutes at least once per week.[14] Also, a cross-sectional survey of more than 3,000 U.S. adults showed that using trails once a week was associated with a 2.3 greater odds of being regularly active.[13]

Correlates of Trail Use

Correlational studies (n = 13) that reported statistically significant positive or negative associations or null findings for correlates of trail use are shown in Table 4.[11,13,15–26] The outcomes or dependent variables in these studies included self-reported trail use and objective measures of trail traffic obtained by infrared monitors or direct observation. For studies that presented multiple statistical models of trail use, the results for the model that the authors indicated was the best-fitting model are reported. In cases where the results were mixed, (ie, no clear model emerged as best fitting), the overall results for the models involved are reported (eg,[17]).

Given the multiple levels of influence of the correlates reviewed, the following summary is organized in terms of a social-ecological model,[60,61] which provides a framework for understanding influences on behavior at the intrapersonal, interpersonal, and environmental levels. None of the studies in this review examined interpersonal correlates of trail use.

Intrapersonal Correlates. Demographic correlates of trail use were examined in 10 studies.[11,13,17–21,23,24,26] Age was negatively associated with trail use in 5 of the 10 studies testing this variable.[19,20,23,24,26] For example, for every 10-year increase in age, participants in 1 study were 33% less likely to use trails.[26] Positive associations for racial and ethnic minority status were found in 3 studies; minority groups were more likely to use trails as compared with non-Hispanic Whites.[19,20,24] However, 2 studies found negative associations,[18,23] and 3 had mixed or null findings for race and ethnic minority.[11,13,17] All 7 of the studies that examined education found positive associations.[11,13,18–20,23,26] For example, 2 studies showed that some college education or more was associated with a 1.4 to 2.2 times greater odds of using trails.[13,26] Income was positively associated with trail use in 3 of 6 studies.[11,19,20] For example, annual income greater than $35,000 was associated with a 20% greater odds of using trails.[11] Gender was not associated with trail use in 4 of the 7 studies to examine gender.[13,17,18,23] However, 2 studies found significant associations; men were 1.9 times more likely to use trails in 1 study,[26] and in the other study women were 1.7 times more likely to use trails.[11] Employment status was a positive correlate in 1 study with employed adults reporting using trails twice as frequently as those who were unemployed.[24] Children in the home was a negative correlate of trail use in 1 study and explained 25% of the variance in frequency of trail use.[18]

Behavioral and physiological correlates of trail use were examined in 3 studies.[11,13,26] Regularly walking and being regularly physically active were associated with a 1.7 and 2.3 times greater odds of using trails, respectively.[11,13] Having a long-term illness or injury compared with no physical activity limitations was associated with a 57% lower odds of using trails.[26] Obesity compared with normal weight was not associated with weekly trail use in a nationally-representative study.[13]

Psychological correlates of trail use were examined in 2 of 13 correlates studies.[21,22] In a study of 3 rail-trails in different regions of the U.S., the level of importance an individual ascribed to the type of activity done on the trail (r = 0.20–0.33), and measures of place attachment, specifically place dependence and place identity (r = 0.17–0.39), were correlated with frequency of trail use.[21] In a study of trail users in Virginia, measures of activity involvement and place attachment were both significant factors in predicting time spent on trails and distance traveled to access trails.[22]

Environmental Correlates. Attributes of trails were tested as possible correlates of trail use in 6 of the 13 correlates studies.[11,19,20,22,25,50] Available parking near trail access points was positively correlated with trail traffic on an Indianapolis trail system in 2 related studies.[19,20] Specifically, for every 1 square foot increase of parking lot area there was a small (less than 0.1%), but significant increase in trail traffic counts.

In Virginia, the type of trail (eg, rail-trail vs. non rail-trail) was not associated with the frequency of use.[22] The type of surface was associated with trail use in the southeast Missouri area; participants were 70% less likely to use trails covered with chat material compared with asphalt.[11] On an Indianapolis trail system, trail segments that were mostly unpaved had lower levels of use than segments that were mostly paved.[50] In southeast Missouri, trail length was associated with use, specifically trails a 1/4 to 1/2 mile in length were twice as likely to be used than shorter trails.[11]

Views along trails and trail conditions were found to be associated with trail use in a study of more than 17,000 trail users on urban trails in Los Angeles, Dallas, and Chicago.[25] After controlling for population density and location, trail segments with mixed views of urban and natural scenery had 39% more trail traffic than those that had only natural views. Trail segments that were maintained in excellent condition had 32% more traffic than those in fair condition, and 73% more traffic than segments with poor condition. The presence of litter and noise was associated with 20% to 33% less traffic, dense vegetation areas were associated with 9% to 25% less traffic, and presence of drainage canals and tunnels were associated with 18% to 49% less traffic.

In 12 of 13 studies characteristics of neighborhoods were examined as correlates of trail use.[11,13,16–21,23–26] The most prominent and consistent finding was that distance from home to a trail was found to have a negative relationship with trail use.[16,18,21,26] Living farther away from trails

Table 4 Cross-Sectional Studies Examining Correlates of Trail Use[a] (n = 13)

Variable	n	Positive association n [References]	Negative association n [References]	Null association n [References]
Intrapersonal				
Demographic				
Age	10	2[18,21]	5[19,20,23,24,26]	3[11,13,17]
Race or ethnicity (referent = White)	8	3[19,20,24]	2[18,23]	3[11,13,17]
Education	7	7[11,13,18–20,23,26]		
Income	6	3[11,19,20]		3[13,18,23]
Gender (referent = female)	6	1[26]	1[11]	4[13,17,18,23]
Employment status	3	1[24]		2[13,18]
Marital status	2			2[11,13]
Number of children in household	1		1[18]	
Home ownership	1			1[18]
Membership in environmental group	1			1[18]
Behavioral and physiological				
Regularly active	2	2[11,13]		
Body mass index	1			1[13]
Physical activity limitation	1		1[26]	
Psychological				
Importance of activity to user	2	2[21,22]		
Place attachment to the trail (months of association)	2	2[21,22]		
Environmental				
Trail				
Greater parking lot area	2	2[19,20]		
Type of trail	1			1[22]
Trail surface (chat versus paved or asphalt)	2		2[11,50]	
Mixed views	1	1[25]		
Surface condition	1	1[25]		
Litter and noise	1		1[25]	
Vegetation density along trail	1		1[25]	
Drains and tunnels	1		1[25]	
Length of trail (1/4–1/2 mile vs. longer and shorter trails)	1	1[11]		
Neighborhood characteristics				
Distance from home to trail	4		4[16,18,21,26]	
Land use mix	4	3[19,20,25]		1[17]
Population density	3	2[19,20]		1[17]
Greenness	2	2[19,20]		
Length of street segments near trail	2	2[19,20]		
County is perceived as an easy place to be active	2	1[13,24]		
Accessibility of trail	1	1[23]		
Safety of the county	1	1[24]		
Midsized community	1	1[11]		
Lack of busy street and steep hill barriers	1	1[26]		
Environmental *(continued)*				
Policy				

(continued)

Table 4 ***(continued)***

Variable	n	Positive association n [References]	Negative association n [References]	Null association n [References]
Support for creating public spaces for people to exercise	1	1[13]		
Willingness to pay taxes to build more parks and trails	1			1[13]
Willingness to pay taxes to support government funded campaigns to promote healthy eating and exercise	1			1[13]
Temporal and weather				
Weekend days and particular months	2	2[19,20]		
Temperature, sunshine, daylight hours	2	2[19,20]		
Precipitation (rain and snow)	2		2[19,20]	

[a] Outcomes included self-reported trail use from surveys and trail counts from direct observation or infrared counters.

was associated with a 16% to 42% lower odds of using trails.[16,21,26] In Raleigh, North Carolina, distance explained 45% of the variance in the frequency of trail use.[18]

Population density was found to be a correlate of trail use in 2 Indianapolis studies; for every 100 residents per square kilometer, there was 2% more trail traffic on nearby trail segments.[19,20] Additionally, in southeast Missouri, residents living in a midsized community (ie, 5500–10,000 residents) compared with a smaller community (<5500 residents) were twice as likely to use walking trails.[11] In contrast, a study of 2 communities in Michigan found mixed results for the association of population density with trail use.[17]

In 4 studies that examined land use mix, 3 found positive associations with trail use.[19,20,25] In 2 Indianapolis studies, for every 1% increase in the percentage of commercial land use there was an almost 1% greater amount of trail traffic.[19,20] Also in Indianapolis, the presence of cafés near trails was associated with 46% more trail traffic.[25] In the study of 2 Michigan communities the results were mixed for the correlations of land use mix and trail use.[17] An innovative measure of accessibility that accounts for the presence of attractive facilities and amenities along a linear trail in Indianapolis was positively related to use.[23]

Other aspects of the community built environment examined in trail correlates studies included steep hills, busy streets, and trail accessibility. Residents of a Massachusetts suburb who did not perceive busy streets between their home and a nearby trail were twice as likely to use the trail compared with those who did report busy streets.[26] However, an objective measure of busy streets was not associated with trail use. In that same study it was also found that residents who did not have an objectively-measured steep-hill barrier between the trail and their home were almost twice as likely to use trails.[26] However, the perception of a lack of steep hill was not associated with trail use.

A U.S. national study found high ratings of 'the importance of the activity friendliness of the neighborhood when choosing a place to live' increased the likelihood of using trails at least once per week by 40%.[13] Among residents in 2 South Carolina counties, adults' perceptions of the county as an 'easy place to be active' and 'safe' were positive correlates of trail use.[24]

Relationships between policy factors and trail use were examined in 1 of the 13 correlates studies.[13] A U.S. national trail use study found that 'willingness to pay taxes to build more parks and trails' and 'supporting taxes to fund campaigns that promote healthy eating and exercise' were not associated with using trails at least once per week. However, strong support for 'expanding public places for people to exercise' was associated with 50% greater odds of using trails.

Temporal patterns and the influence of weather on trail traffic were examined on trails in Indianapolis.[19,20] Weekend days and the spring and summer months, were associated with higher trail traffic counts.[19,20] Sunny days and the number of daylight hours were positively correlated with trail traffic, and higher precipitation and deviations from the annual mean temperature were negatively associated with trail traffic.[19,20]

Facilitators and Barriers of Trail Use

Facilitators and barriers to trail use were examined in 31 descriptive studies[12,14,27–55] (see Table 5). These studies were not classified as correlational because they did not test for associations between facilitators or barriers and a trail use or physical activity outcome.

Table 5 Descriptive Studies Examining Facilitators and Barriers of Trail Use (n = 31)

	# of studies that cite as a facilitator [References]	# of studies that cite as a barrier [References]
Intrapersonal		
Appreciation of nature or the outdoors	6 [28,29,32,34,39,49]	
Personal fitness or health	5 [28,32,36,39,43]	1 [53]
Relaxation, solitude, or physical/psychosocial escape	4 [28,29,39,49]	
For a challenge, personal control, autonomy	3 [28,29,39]	
Fun and enjoyment	2 [34,39]	
Information about or awareness of the trail	2 [45,47]	1 [53]
Attachment to the trail	1 [40]	
Desire to learn about the history of the area	1 [29]	
Lack of time		1 [53]
Lack of money		1 [53]
Age		1 [53]
Education	1 [55]	
Interpersonal		
Negative interactions among users		7 [27,30,32,35,38,42,55]
Friends or family member to use trail with	3 [28,49,55]	1 [53]
Community pride and community identity	2 [36,52]	
Friendly atmosphere and opportunity to meet new people	2 [34,42]	
Environmental		
Trail		
Trail availability or convenience to home	7 [30,36,41,42,51,52,54]	3 [39,53,55]
Trail design (eg, surface, street crossings, width, length, access points, terrain level, accessible for disabled)	4 [29,32,42,51]	3 [27,30,39]
Aesthetics or scenic features	7 [29,30,36,41,42,52,54]	
Amenities (eg, restrooms, water fountains, trash cans, recycling cans, parking for vehicles, signage, mile markers, lighting, etc.)	3 [29,32,51]	4 [30,39,42,55]
Safety	3 [41,42,51]	2 [30,55]
Maintenance or cleanliness	2 [30,41]	2 [27,42]
Freedom from motorized transportation	2 [30,51]	
Active transportation or commuting opportunity	2 [32,43]	
Cultural history of the area	1 [29]	
Lack of services (eg, food and bike repair)		1 [30]
Policy		
Preservation of open space	1 [36]	
Land-use patterns that support multiple uses	1 [52]	
Development of trails	1 [41]	
Funding for trails		1 [27]

Intrapersonal Facilitators and Barriers. Opportunities for relaxation, solitude or a physical and psychosocial escape,[28,29,39,49] the challenge and opportunity to exhibit personal control and autonomy,[28,29,39] and fun and enjoyment[34,39] were facilitators of trail use found in several studies. In Indianapolis, 70% of surveyed trail users reported that they used trails primarily for outdoor leisure and to appreciate nature,[32] and in Cleveland, Ohio trail users scored "exercise" as the most motivating factor for their trail use.[39] On a trail in Rocheport, Missouri, 27% of users scored 'health and fitness' motivations as the highest.[28] In Wisconsin, 23% of community residents indicated 'poor health' was a barrier to using trails.[53] They also reported lack of information, time, money, and increasing age prevented them from using trails.[53] The majority (73%) of university students who were aware of a recreational trail near campus used it at least once in the previous month.[47] In a South Carolina county approximately 1/3 of residents who were aware of a community trail within a 10-mile radius of their home used a trail.[45]

Interpersonal Facilitators and Barriers. More than 1/3 (37.5%) of trail users reported the lack of trail ethics by users and too many different types of users were major problems on trails in Arizona.[27] In New Zealand, 21% of walkers reported conflicts among users, (eg, bicyclists detracted from their use of the trail).[38] In Cleveland in-line skaters and bicyclists were reported to have the greatest negative impact on other user groups.[35] The most common complaint was that in-line skaters and bicyclists traveled too fast and failed to give adequate warning when passing from behind.

The lack of a companion was a barrier to trail use among 15% of surveyed Wisconsin residents.[53] Being with friends and family was one of the most important reasons for using trails among Latino trail users in Chicago.[49] Similarly, among 421 rail-trail users in Rocheport, Missouri, the importance of meeting new people and maintaining social contacts was an important benefit of using trails.[28]

In Texas, community pride was rated highly as a perceived benefit of local trails.[52] Furthermore, in a survey of more than 1700 trail users throughout the U.S., 'a strong community identity' ranked third out of 5 perceived benefits of trails.[36]

Environmental Facilitators and Barriers. The availability of trails near homes was a facilitator of trail use in 7 studies.[30,36,41,42,51,52,54] In Chicago, close proximity of a trail was one of the most influential factors reported to affect use.[54] Poor availability of trails was identified as a barrier in 2 studies.[39,53] For example, 22% of Wisconsin residents reported lack of availability was a major barrier to using trails.[53]

Paved trails facilitated trail use in 4 studies[29,32,42,51] and rough or damaged trail surfaces were negative attributes of trails that needed attention in 3 studies.[27,30,39] In Arizona, almost 1/4 of trail users rated erosion and deterioration of the trail as an important issue in need of attention.[27] The presence of litter and glass[27,30,41] and the lack of amenities or facilities (ie, restrooms, water fountains, and trash and recycling cans)[30,39,42] along the trail were barriers to trail use in several studies. For example, about 20% of trail users in Arizona identified litter and trash on the trails as an important issue that needed to be addressed.[27] In Ohio, younger trail users were more likely than older users to report problems with comfort amenities.[39]

Safety or lack thereof was perceived as either a facilitator or barrier to trail use.[30,41,42,51,55] For example, in a West Virginia county, safety of trail use was found to be of greater concern to new exercisers than to habitual exercisers.[42] On 13 greenway trails in the Chicago area, the lack of police on trails was a deterrent to trail use.[30] Additional environmental factors that were found to facilitate trail use included the preservation of open space, diverse land use, and the appropriate development and funding of trails.[27,36,41,52]

Economics of Trails for Promoting Physical Activity and Recreation

The benefits and costs of trail use from a recreation and health perspective were examined in 5 of the 52 studies identified in this review.[36,56–59] Two of these studies used the travel cost method, which is based on the premise that the costs of time and travel incurred in getting to and from and using a recreation resource (such as a trail) represent the price people would pay to access that resource. The total value or benefits of the resource are the aggregate of people's "willingness to pay" based on the number of trips they make at different travel costs.[59] In one study, estimates of the value of using a trail were developed using an individual travel cost approach for 3 different trails (one each in California, Florida, and Iowa).[36] According to this analysis the value of using the trails ranged from $4.81 to $49.78 per user per trip. Based on the total trips to each trail, the annual benefits associated with each trail ranged from $1,967,049 to $8,550,909; and the benefits per mile ranged from $156,687 to $534,432. A similar analysis was conducted using a zonal travel cost approach for an urban greenway in Indianapolis.[59] In this study, the benefit values across the 4 study zones ranged from $0.19 to $19.67 per user per trip; with the overall annual benefits estimated at $3,065,257 and the per-mile benefits at $289,516 (based on a length of 10.6 miles).

The costs, benefits, and cost-effectiveness of developing and maintaining trails in Lincoln, Nebraska were examined in 3 related studies.[56–58] These studies were conducted using cost data, trail user counts, estimated medical expenditures, and data from a survey of trail users on several different trails. The cost of constructing and maintaining 5 different trails ranged from $25,762 to $248,279 per trail.[58] The most expensive trail had concrete surfaces and bridges, and the least costly had a limestone chip surface and no bridges. The costs per user ranged from $83 to $592/year, and per mile of trail ranged from $5735 to $54,017/year.[58] Using estimated medical expenditure data from the National Medical Expenditure Survey, the benefit-cost ratio of trail use was calculated with respect to the direct medical benefits of being physically active.[57] The average benefit to cost ratio was 2.94 (range 1.65 to 13.40), meaning that for every 1 dollar invested in trails there was an associated $2.94 in direct medical benefit.[57] The cost-effectiveness of investing in trail construction and maintenance for increasing physical activity, and for promoting physical activity for health and for weight loss were also estimated.[56] The cost-effectiveness for increasing physical activity was estimated at $98/user.[56] Greater cost-effectiveness was seen among those who were physically active and used trails for general health reasons ($142/user), and for those who were physically active and used trails for weight loss reasons ($884/user).[56]

Discussion

Overall, this review of 52 studies of trail use indicates that most research attention has focused on the facilitators and barriers of trail use and to a somewhat lesser extent on the correlates of trail use. Furthermore, few studies have been conducted to evaluate the effects of new trails and trail use promotion on community physical activity levels. Only 3 studies[8–10] used prospective designs to examine the effects of trails and trail use promotion on physical activity levels and 5 other studies examined correlations between trails and physical activity.[11–15] Overall the evidence for the effects of trails on physical activity was mixed and in some cases negative effects were found (see Tables 2 and 3). Additional prospective and quasi-experimental studies are needed to build upon the current evidence. Future studies on trail use and physical activity should use quasi-experimental designs that take advantage of natural experiments (eg, new trail construction) and include comparison sites. These types of evaluation designs could help to control for secular changes in physical activity that might be occurring in a particular geographic area. In addition, consistent with the recommendations of the Taskforce on Community Preventive Services, more intervention studies are needed in which new trail construction is combined with informational outreach strategies.[3,4] Only 2 studies in this review used media and informational strategies to promote awareness and use of community trails.[8,10]

Public health and physical activity researchers interested in evaluating the impact of trails on physical activity should seek collaborations with urban, transportation, and community planners. However, there are likely to be challenges to conducting these types of collaborative projects. Coordination between researchers, who have to obtain funding to carry out the prospective evaluation, and planners and trail developers, who have their own set of challenges (eg, obtaining funding for construction and contending with the multiple phases in the planning and construction process) could be an obstacle in conducting this type of evaluation research.[62] An additional challenge in planning and implementing prospective evaluations of trails is that it typically takes time to demonstrate a measurable effect on physical activity levels within a given target population.[63] This further underscores the importance of receiving sustained funding to monitor potential changes over a longer time-frame.

Despite the lack of evidence from prospective studies, the correlational and other descriptive studies examined in this review provide important information that can be used in efforts to promote trail use and physical activity. The results indicated that several intrapersonal and environmental factors are related to higher levels of trail use. Distance from home to a trail had a consistent and negative association with trail use, reaffirming the important work being carried out in many communities to develop more trails. In addition, there was consistent evidence that education and income are positively associated with trail use, suggesting that more efforts are needed to encourage trail use among lower socioeconomic groups. However, the evidence was mixed for other demographic correlates of trail use, such as age, race and ethnicity, and gender. Relatively few studies examined behavioral, physiological (eg, physical-activity limitations, weight status), psychological correlates (eg, place attachment to the trail), or environmental variables such as trail features, amenities, and characteristics of the neighborhood environment around trails. None of the studies in this review examined interpersonal correlates of trail use, such as social support or role modeling. Further research is needed to fully understand influences on trail use and trail-related physical activity. The barriers and facilitators of trail use identified in this review could be explored as potential correlates or mediators of change in trail use.

A general concern noted in this body of research was use of instruments that had not been validated for assessing trail use and physical activity. Because of the well-known biases inherent in self-report instruments,[64] it is recommended that future investigations test and report on the validity of such surveys. A recently published trail use survey was found to have moderate test-retest reliability, however the validity of the instrument has not been examined to date.[65] The use of innovative tools and techniques such as accelerometers, pedometers, global positioning system (GPS) devices, and geographic information systems should also be considered for more accurate, unbiased, and contextualized measurement of trail use and physical activity. GPS devices and accelerometers can be used in tandem to determine a participant's location (eg, on a specific trail segment), and concurrent physical activity levels.[66] Another general limitation among the studies included in this review was the number of studies that did not report on the study setting (ie, urban, suburban, or rural) or sample characteristics (ie, age, gender, race, education). Future studies should include this type of information so that inferences about the generalizability of the findings could be made.

In the few studies to examine the health and physical activity-related economics of trails the evidence generally showed trails are cost-effective in promoting health and that the benefits exceed the costs of building trails. However, it should be noted that several of these studies were carried out on a single trail system in Nebraska, and the findings may not be generalizable to other types of trails and different geographical areas. Additional research is needed to determine whether the cost-effectiveness and cost-benefits demonstrated in these few studies could be replicated with other trail systems.

Although beyond the scope of this review (because the authors did not examine the direct health or recreational benefits of trails), it should be noted that several studies have examined the impact of trails on property values[59,67,68] and tax revenues.[69] These studies are important because they show that trails potentially have multiple types of economic benefits. Clearly, additional research examining the range of economic benefits trails provide would be useful for garnering support for the development of trail systems.

An important gap in the current literature is the lack of data on trail use among racial and ethnic minorities, older adults, and youth, and similarly no data on how trails may positively influence physical activity among these groups. Two related studies in several southeast Missouri communities over-sampled African-Americans,[10,11] and 1 study in Chicago exclusively focused on Latino trail visitors.[49] In light of the racial and ethnic disparities in physical activity in the U.S., trail studies that focus on groups such as Latinos, African-Americans, and Native Americans are needed. One potential line of research could be pilot interventions using informational outreach and intergenerational strategies that specifically encourage children, youth, and older adults to use local trails.

Finally, the majority of the studies in this review did not identify a conceptual framework for understanding trail use and physical activity behaviors, although 9 studies did refer to a social-ecological model.[8–10,16,26,45,46,52,55] Several other theoretical frameworks were identified in this literature, including place attachment theory,[21,22,40] conflict theory,[27,35,38] social cognitive theory,[26] opportunity theory,[53] and mean-ends theory.[29] Further research is needed to develop a conceptual model of the determinants of trail use and the relationship of trail use with regular physical activity. This work could potentially facilitate the use of common measures across studies, which could lead to stronger conclusions regarding the effects of trails on physical activity and the determinants of trail use. Similar conceptual work has been conducted on parks and physical activity.[70]

This review provides a synthesis of the recent evidence related to trails and physical activity and thus represents a useful point of reference for future studies on trails. Recommendations for future research included the need for prospective evaluations of the effects of trails and trail use promotion on physical activity, validation of measures of trail use and physical activity, further examination of the determinants of trail use including intrapersonal, interpersonal, environmental and policy-level correlates, and a focus on trail use among minorities, older adults, adolescents and children.

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