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Cost effectiveness of a bicycle/pedestrian trail development in health promotion

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Abstract

Background. A persistently low population level of physical activity is a challenge for public health. Data on cost effectiveness of environmental interventions are needed to inform the development and implementing of such interventions.

Objective. To conduct cost-effectiveness analysis of bicycle/pedestrian trails.

Design. The costs of trail development and number of users of four trails in Lincoln, NE, were obtained. The costs were adjusted to 2003 dollars. The physical activity-related outcomes/items are number of users who were more physically active since they began using the trails, number of users who were physically active for general health, and number of users who were physically active for weight loss. Cost-effectiveness measures were derived. Sensitivity analysis was performed.

Results. The annual trail development cost US$289,035, 73% of which was construction cost. Of the 3,986 trail users, 88% were active at least 3 days a week. The average annual cost for persons becoming more physically active was US$98 (range US$65–253); the cost was US$142 (range US$95–366) for persons who are active for general health, and US$884 (range US$590–2,287) for persons who are active for weight loss.

Conclusion. This analysis provides basic cost-effectiveness measures of bicycle/pedestrian trails. Policymakers can use this information in making resource allocation decisions.

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Keywords: Environmental intervention; Physical activity; Economics

Introduction

Many studies have documented the health benefits associated with a physically active life, yet most Americans do not achieve sufficient levels of physical activity to obtain these benefits [1–4]. Furthermore, the economic burden of physical inactivity is substantial [5–9]. One study suggested that in 1994 US$5.6 billion could be saved from coronary heart disease costs alone if 10% of adults began a regular walking program [9]. Another study found that the direct medical cost associated with physical inactivity in 1987 could be as high as US$76.6 billion (in year 2000 dollars) [6]. Despite the importance of physical activity in reducing morbidity and mortality from chronic diseases and in reducing health costs, in the past decade, the prevalence of physical inactivity has remained around 30% for adults (persons aged 18 years or older) and the prevalence of achieving the recommended levels of physical activity for health benefits has remained around 25% [10].

To support individual decisions to become more active, environmental interventions have been discussed as possible strategies [11,12]. Lack of accessible facilities has been identified as one of the major deterrents to a physically active lifestyle [11–20]. Lifestyle interventions can be as effective as structured interventions in increasing physical activity [21]; thus, for example, availability of sidewalks and bicycle/pedestrian trails may encourage such lifestyle activities as walking and cycling. Although a physical activity-friendly environment is considered an essential

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component of community health promotion efforts, research on the cost effectiveness of environmental and policy interventions such as building bicycle/pedestrian trails, is lacking. To develop or implement such interventions, policymakers and community organizations need the information on the cost and effectiveness of environmental interventions.

Several cost-benefit and cost-effectiveness studies of physical activity programs have been conducted, but they focused on a clinical population or other specific populations such as seniors with knee osteoarthritis [9,22–29]. There are few data on the cost effectiveness of environmental facilities on promoting physical activity in the general population. Physical environments are among the least studied of the potential influences of physical activity; there are virtually no studies of the economic evaluation of these physical environments [19]. A recent study suggested that construction of walking trails may be a viable intervention strategy for physical activity interventions, but did not provide economic justification of such intervention [13]. Although the provision of more physical activity facilities and programs is promising, studies testing their efficacy in promoting physical activity are lacking [1].

We conducted a cost-effectiveness analysis of bicycle/pedestrian trails by assessing the cost of construction and maintenance of the trails and three physical activity-related outcomes/items: number of trail users who were more physically active since they began using trails, number of trail users who were physically active for general health, and number of trail users who were physically active for weight loss.

Data and methods

Cost of trail development and number of trail users

We obtained costs of construction and maintenance of four bicycle/pedestrian trails and number of trail users in a Nebraska city from the 1998 Lincoln Recreational Trails Census Report and communications with the Department of Parks and Recreation of Nebraska (Table 1) [30]. We assumed the trails could be used on average for 30 years and allocated the construction cost evenly over the period. Because the trails were built in different years, the construction costs of the trails were adjusted to 2003 dollars using inflation calculator of the U.S. Department of Labor (available in www.bls.gov). We derived the annual total cost by summing all the costs of construction and maintenance. We added the annual total cost of the four trails as the cost of trail development. The land value was not listed as a separate cost item. It should be included in construction cost if any.

The census report also provided the number of users for a day (July 12, 1998) on the four trails. The census began at 7:00 am and concluded at 9:00 pm that evening. The census volunteers who worked 2-h shifts, counted cyclists, runners, walkers, in-line skaters, and miscellaneous users (such as persons with skate boards, wheelchairs, horses, etc). A total of 3,986 users were recorded on the four trails. We used the total number of trail users as the study sample for cost-effectiveness analysis. Because the census was conducted on Sunday in summer (July 12, 1998), the number of users may not be reasonable for our analysis. To validate this number, we obtained the number of trail users from a trail project in Missouri (personal communication). We found that the number of users was the lowest on Saturdays and Sundays and the highest on Wednesdays and Thursdays. In fact, the number of users on Wednesday might be more than twice as high as the number on Sunday in the trail project. Based on this information and Nebraska climate (3–4 months winter), we felt the number of users reported in the census report was acceptable for this analysis.

Physical activity-related outcomes/items

We identified three physical activity-related outcomes/items from a 1998 Trail Interview conducted on the four trails by Nebraska Health and Human Services System. The interview questionnaire, conducted on July 7 and 12, 1998, was completed by 378 trail users (Table 2). The first outcome/item is the number of users who were more physically active since they began using the trails. It was derived by multiplying the total number of users (from the census report) by the percentage of trail users who

Table 1
Number of users and costs of construction and maintenance of trails (2003 US$[a])

Trail description	Date built	Trail length (miles)	Number of users[b]	Construction cost (US$)		Maintenance cost per year (US$)
				Total	Annual[c]	
Concrete with two bridges	1995	4.6	1,638	2,850,017	95,001	29,477
Limestone chip	1997	4.5	232	104,020	3,467	16,864
Concrete with three bridges	1996	4.1	1,878	1,896,922	63,231	13,316
Concrete	1989	3.1	238	1,449,612	48,320	19,359
Total			3,986	6,300,571	210,019	79,016

[a] The cost was inflated to 2003 dollar value by using inflation factors from the U.S. Department of Labor (available at: www.bls.gov).
[b] Number of users was from the census report conducted on July 12, 1998.
[c] The annual cost was derived by dividing the total cost by 30 years.

Table 2
Selected results of the 1998 Trail Interview Survey (N = 378)

Survey items or questions	Results
Age	19–88 years old, mean = 43 years
Gender	50% male
Type of trail user	40.6% walker, 39.3% cyclist, 17.4% jogger
Main reason for being physically active	51.1% for general health, 17.1% for enjoyment and to feel better, 10.6% for personal fitness, 8.2% for weight loss
Participate in some form of physical activity most days (>3) of the week	88% yes, 12% no
Number of times using the trails each week	mean = 4.3 times
Time spend on trails when using it	mean = 69 min
Has using the trail changed the number of times you are physically active?	70.6% increase, 1.1% decrease, 27.2% same, 1.1% don't know
Are you more physically active since you began using the trails?	74% yes, 26% no

reported being more physically active since they began using trails (from the trail interview). This outcome/item indicates the effectiveness of the trails in promoting physical activity.

The second outcome/item is the number of users who were physically active for general health purposes, which was derived by multiplying the total number of trail users (from the census report) by the percentage of the trail users who reported being physically active for general health (from the trail interview). This outcome/item suggests the effectiveness of the trails in motivating physical activity for health in general.

The third outcome/item is the number of users who were physically active for weight loss. We selected this one because of the high and increasing prevalence of overweight and obesity in the United States, and the close relationship between overweight and physical activity. For example, during 1988–1994 among adults 20–74 years old, the prevalence of overweight (body mass index, ≥ 25 kg/m^2) was 54.4% and the prevalence of obesity (body mass index, ≥ 30 kg/m^2) was 22.5% [31], and the prevalence of obesity among U.S. adults has increased over the past two decades [31,32]. One main purpose of being physically active may be weight loss. We obtained this measure by multiplying the total number of users (from the census report) by the percentage of users who reported being physically active for weight loss (from the trail interview).

Cost-effectiveness ratios and sensitivity analyses

We derived cost-effectiveness ratios by dividing the costs of trail development and maintenance (total cost of the four trails) by the selected physical activity-related outcomes/items related to using trails. The cost-effectiveness ratios show the cost required for one unit of physical activity-related outcomes/items achieved (e.g., the cost required for one person who became more physically active since the person began using the trails).

We conducted sensitivity analyses by worst- and best-case scenarios for two main parameters that may affect the cost-effectiveness ratios greatly, number of trail users, and usable years of trails. The number of users was from the census report, which was conducted on a certain day, but the number may vary greatly over a year because of seasonality or other effects. If the number of users increases, the trail development will be more cost effective; otherwise, the trail development will be less cost effective. We varied the number of trail users by decreasing (worst case) or increasing (best case) by 50% from the number of trail users listed in the census report. How long a trail will last is also uncertain. Because the construction cost is a big investment and is the major cost (73%) associated with trails, correctly allocating the total investment cost over a time period is important for evaluating this type of environmental development. We believe a trail can be used or exist for at least 10 years and less than 50 years. So we varied the usable years of trails from 10 years (worst case) to 50 years (best case).

Results

In 2003 dollars, the annual construction costs ranged from US$3,467 to US$95,001 among the four trails; the annual maintenance cost ranged from US$13,316 to US$29,477 (Table 1). Summing the construction and maintenance costs of the four trails, the annual total cost was US$289,035. Among the four trails, the number of users ranged from 232 persons to 1,878 persons, for a total of 3,986 persons.

Table 3
Cost effectiveness of trails in promoting or supporting physical activity and public health (2003 US$)

Item	Value
Trail development costs (US$/year)	
Construction of trails	210,019
Maintenance of trails	79,016
Total	289,035
Physical activity-related outcomes/items (number of persons)[a]	
Users who are more physically active	2,950
Users who are physically active for general health	2,037
Users who are physically active for weight loss	327
Cost-effectiveness ratio (US$/user)[b]:	
Cost per user who is more physically active	98
Cost per user who is physically active for general health	142
Cost per user who is physically active for weight loss	884

[a] Physical activity-related outcomes/items were derived by multiplying the total number of trail users by the percentage of users who changed their health behavior or were motivated for physical activity.
[b] Cost-effectiveness ratio was derived by dividing the trail development cost by physical activity-related outcomes/items.

Table 4
Sensitivity analyses of cost effectiveness of trails for promoting or supporting physical activity

Item	Best-case scenario		Worst-case scenario	
	Number of users increase by 50% (US$)	Trail used for 50 years (US$)	Number of users decrease by 50% (US$)	Trail used for 10 years (US$)
Cost per user who is more physically active	65	73	196	253
Cost per user who is active for general health	95	106	284	366
Cost per user who is active for weight loss	590	661	1,773	2,287

The age of trail users ranged from 19 to 88 years, and 50% of them were men (Table 2). Mainly, they were walkers, cyclists, or joggers. Most (88%) of the users participated in some form of physical activity at least 3 days a week. On average, the users were on the trails 4.3 times a week and spent 69 min per visit. For the physical activity-related outcomes/items, 74% of the users were more physically active since they began using the trails; 51% of the users were physically active for general health; and 8.2% for weight loss. Thus, of the 3,986 trail users, 2,950 persons were more physically active since they began using the trails, 2,037 persons were physically active for general health, and 327 persons were physically active for weight loss (Table 3). The corresponding cost-effectiveness ratios were US$98, US$142, and US$884.

Sensitivity analyses showed that when we increased the number of trail users by 50%, the cost of trail development and maintenance was US$65 for a user who was more physically active since the user began visiting the trails; decreasing the number of users by 50% resulted in a cost of US$196. The cost for a person who was more physically active since the person began using the trails ranged from US$73 to US$253 when the life of trails decreased from 50 to 10 years. The range from best-case to worst-case scenarios was US$95–366 for a person who was physically active for general health, and US$590–2,287 for a person who was physically active for weight loss (Table 4).

Discussion

In this study, construction cost arose as the major component (73%) of the costs of bicycle/pedestrian trail development. Among the four trails, the construction cost varied greatly by surface type and the number of bridges, whereas the annual maintenance cost did not vary much. The high variation in construction cost suggests that building trails is financially feasible across high-income to low-income communities. The number of users on each trail also varied greatly. These data are consistent with logic that the location and quality of trails should affect the number of users. Because both the cost of development and number of users determine the cost-effectiveness measures, they should both be considered when a community develops or implements a trail intervention.

Because previous cost-effectiveness studies in physical activity promotion focused on a specific population group or health outcome such as inactive people [24,28] and life year saved [27,29], we cannot compare our results with those in the literature. One research showed that the cost of moving a person out of the sedentary group was near 650 pounds in Great Britain [28]. This was based on a 10-week program targeting on inactive people aged 45–74. Unfortunately, in our study, we did not have such physical activity information. Our results shown that US$98 was required for a person to become more physically active. If only inactive persons were targeted, our cost-effectiveness ratio should be closer to those from the literature.

Among all the trail users, 97% were walkers, cyclists, or joggers. Our finding suggests that availability of trails should facilitate these activities—particularly walking, which is the most commonly reported leisure-time physical activity in the United States [1]. Further, most trail users were physically active on at least 3 days a week, which implies that if trails are available, physically active persons will use them. The mean number of times (4.3 times/week) a user used trails and the mean time spent on trails (69 min/time) indicate that most of the people may be close to meeting the U.S. recommended level of physical activity (e.g., at least 30 min a time, five times a week on walking or biking) [33].

Our study has several limitations. First, the cost of trail development was based on four trails in a Midwest city, limiting the representativeness of this information because the cost of construction and maintenance of trails likely varies greatly across communities. Even so, the variety of the trails covered in this study should enhance the generalizability of our findings at the local community level. Similarly, the number of trail users was based on the four trails, limiting the generalizability of our findings because the number of users and the density of trails may vary greatly in different regions and seasons. The cost-effectiveness ratio is limited by the small sample size. Hopefully, our sensitivity analysis on the number of trail users resolves this problem to some extent. We believe that the range of varying the number of users by decreasing or increasing 50% from the number listed in census report should cover most cases in communities. Second, the measure of physical activity-related outcomes/items may bias the cost-effectiveness estimates. We know the changing direction of physical activity before and after using the trails, but baseline information on the levels of physical activity is lacking. Therefore, we do not know whether a trail user who became more physically active by using trails was moving from an inactive to an active lifestyle or from an insufficiently active to a sufficiently active lifestyle.

Third, in the trail interview, the main reasons for being physically active listed were mutually exclusive. This format may have led to a conservative estimate of cost effectiveness for the last two physical activity-related outcomes/items (number of users physically active for general health and number of users physically active for weight loss). Finally, due to data limitations, we conducted the analysis using a year as the time frame, and no discount was applied to the cost. In addition, some costs such as time value of trail users were not included. This may overestimate the cost effectiveness of the trail development. However, we know the main purpose of building trails may not be public health. The impact of trails on health behavior may be a by-product of building trails. Therefore, it is nearly impossible to include all the costs and benefits for a concrete economic analysis.

Despite its limitations, our study appears to be the first cost-effectiveness study in the environmental interventions for health promotion for the general population. The study provides a set of basic cost-effectiveness measures by compiling the actual cost items of trail development, estimating the number and type of trail users, and identifying several physical activity-related outcomes/items. The sensitivity analyses, in particular, should guide policymakers in understanding the financial resources needed to achieve a certain public health objective.

Conclusion

Information presented in this research could have important policy implications in building physical activity-friendly environments. As additional research provides further insight into the cost effectiveness of trail development, better policy decisions about building bicycle/pedestrian trails could be made. Further research on building a comprehensive data system for economic evaluation research is critical for deriving creditable policy information. In this regard, the translation of economic research into policy formulation and program implementation should be helpful in improving the cost effectiveness of public health programs.

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