A Cost-Benefit Analysis of Physical Activity Using Bike/Pedestrian Trails

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From a public health perspective, a cost-benefit analysis of using bike/pedestrian trails in Lincoln, Nebraska, to reduce health care costs associated with inactivity was conducted. Data was obtained from the city's 1998 Recreational Trails Census Report and the literature. Per capita annual cost of using the trails was U.S.$209.28 ($59.28 construction and maintenance, $150 of equipment and travel). Per capita annual direct medical benefit of using the trails was $564.41. The cost-benefit ratio was 2.94, which means that every $1 investment in trails for physical activity led to $2.94 in direct medical benefit. The sensitivity analyses indicated the ratios ranged from 1.65 to 13.40. Therefore, building trails is cost beneficial from a public health perspective. The most sensitive parameter affecting the cost-benefit ratios were equipment and travel costs; however, even for the highest cost, every $1 investment in trails resulted in a greater return in direct medical benefit.

Keywords: *environment; community; inactivity; economic analysis*

Inactivity as an independent risk factor for many chronic diseases, such as coronary heart disease, obesity, diabetes, hypertension, some cancers, and some mental disorders, has been investigated by many researchers and summarized in the surgeon general's report on physical activity and health (Brown, Mishra, Lee, & Bauman, 2000; Hassmen, Kiovula, & Uutela, 2000; Martinez et al., 1997; U.S. Department of Health and Human Services [USDHHS], 1996). The economic burden of physical inactivity has also been demonstrated by several researchers (Colditz, 1999; Jones & Eaton, 1994; Keeler, Manning, Newhouse, Sloss, & Wasserman, 1989; Nicholl, Coleman, & Brazier, 1994; Pratt, Macera, & Wang, 2000). One study estimated that in 1994 U.S.$5.6 billion could be saved from the cost of coronary heart disease alone if 10% of adults began a regular walking program (Jones & Eaton, 1994). Another study estimated that direct medical cost associated with physical inactivity could be as high as $76.6 billion in 1987 (in year 2000 dollars) (Pratt et al., 2000). Despite the importance of physical activity in reducing health costs and morbidity and mortality from chronic diseases, in the past decade, the prevalence of physical inactivity remained around 30% for adults, and the prevalence of achieving the recommended levels of physical activity for health benefits remained around 25% (Centers for Disease Control and Prevention [CDC], 2001).

Because of the health and economic burden of physical inactivity, promoting physical activity has become a public health priority. Studies have shown that lifestyle interventions are as effective as structured interventions in increasing physical activity (Dunn et al., 1999). For activities such as walking and cycling, availability of sidewalks and bike/pedestrian trails may be an important element needed to incorporate physical activity into everyday life. Indeed, lack of accessible facilities has been identified as a deterrent to a physically active lifestyle (Brownson et al., 2000; Corti, Donovan, & Holman, 1997; King, 1991; King et al., 1995, King et al., 1992; Linenger, Chesson, & Nice, 1991; Sallis, Bauman, & Pratt, 1998; Sallis et al., 1990; Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997). It is demonstrated that environments influence physical activity behaviors (Craig, Brownson, Craag, & Dunn, 2002; Owen, Leslie, Salmon, & Fotheringham, 2000). Although a physical activity–friendly environment is considered an essential component of community promotion efforts (Berrigan, & Troiano, 2002; Handy, Boarnet, Ewing, & Killingsworth, 2002), physical environments are the least-studied category of influence on physical activity, and research on the cost benefit of

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environmental and policy interventions (such as trails) is lacking (Sallis et al., 1998).

Several cost-benefit and cost-effectiveness studies of physical activity programs have been published (Hatziandreu, Koplan, Weistein, Caspersen, & Warner, 1988; Jones & Eaton, 1994; Lowensteyn, Coupal, Zowall, & Grover, 2000; Robertson, Devlin, Gardner, & Campbell, 2001; Robertson et al., 2001; Sevick et al., 2000), yet none has examined the economics of environmental facilities, such as bike/pedestrian trails. A study suggested that construction of walking trails may be a viable intervention strategy for physical activity intervention (Brownson et al., 2000) but did not provide any economic justification of such an intervention. In the current study, a cost-benefit analysis of physical activity through constructing and maintaining bike/pedestrian trails in Lincoln, Nebraska, was conducted.

DATA AND METHODS

Construction and Maintenance of Trails

Construction and maintenance costs are usually incurred to the community, local government, or other organizations. The cost of construction and annual maintenance costs of five bike/pedestrian trails in Lincoln, Nebraska, was obtained from a census report (*Lincoln Recreational Trails Census Report*, 1998) and personal communications with Lincoln's Department of Parks and Recreation. In addition to the cost information, the investigators also identified the information about surface types, date built, and length of each trail. It is assumed that the trails could be used for an average of 30 years, and the construction costs were allocated evenly over that period. The annual total trail cost (construction and maintenance) was adjusted to 1998 dollars.

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Trail Use and Trail Cost per Use

The number of users for a day (July 12, 1998) on each of the five trails was obtained from the census report (*Lincoln Recreational Trails Census Report*, 1998). The census began at 7:00 a.m. and concluded at 9:00 p.m. that evening. The census volunteers, who worked 2-hr shifts, counted cyclists, runners, walkers, skaters, and miscellaneous users (such as persons with skateboards, wheelchairs, horses, etc.). Because the census was conducted on a Sunday in summer, the number of users may be improper for the analysis. To determine if the number of users from the census was acceptable, the investigators looked at the number of users across a week and 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 Sundays in Missouri (a state adjacent to Nebraska; personal communication). Based on this information and Nebraska climate (3 to 4 months of winter), it was believed that the number of users reported in the census was acceptable for the analysis. This number was multiplied by 365 days to derive the number of uses of each trail during a year. The trail cost per use was calculated by dividing annual total trail cost by the number of trail uses per year.

Equipment and Travel

Trail users needed to buy some equipment to use the trail for physical activity and had to travel to and from the trails. Such expenses are usually borne by the trail users, which were estimated at $100 per year in 1988 (Hatziandreu et al., 1988). This figure was inflated to $150 in 1998. Ideally, the indirect cost of physical activity, such as the monetary value of time spent doing physical activity, should be assessed because time is one of the most often cited reasons for being physically inactive (Sallis et al., 1990). However, it is assumed that the majority of trail use was during leisure time. In addition, the current study included only direct medical cost saving as the benefits and did not assess the benefit to psychological well-being from physical activity. Therefore, no indirect cost, such as time value, was assessed for the current study.

Direct Health Benefit

The direct health benefit was measured using the estimated difference in the direct medical cost for active persons and their inactive counterparts (excluding persons with physical limitations). The medical cost may be paid out of pocket, through insurance policies, or by government programs. A study using a nationally repre-

TABLE 1
Total Annual Trail Cost ($), Annual Number of Trail Users, and Trail Cost per Use in 1998

Data Source	*Annual Trail Cost* — *Construction*: *Total Construction Cost (Lincoln Recreational Trails Census Report)/ 30 Years*	*Maintenance*: *Lincoln Recreational Trails Census Report*	*Total*: *Construction + Maintenance*	*Annual No. of Trail Uses*: *No. of Uses per day (Lincoln Recreational Trails Census Report) 365 days*	*Trail Cost per Use*: *Total Annual Trail Cost / Annual no. of Trail Uses*
Trails:					
Concrete, 2 bridges, 4.6 miles	91,334	26,183	117,517	597,870	0.20
Limestone chip, 0 bridges, 4.5 miles	3,184	14,980	18,164	84,680	0.21
Concrete, 3 bridges, 4.1 miles	59,608	11,828	71,436	299,300	0.24
Concrete, 0 bridges, 3.1 miles	50,656	17,196	67,852	86,870	0.78
Concrete, 1 bridge, 1.6 miles	19,962	7,040	27,002	58,035	0.47
Average	44,949	15,445	60,394	225,351	0.27

sentative National Medical Expenditure Survey found that, on average, active persons spent $330 (95% CI: $214 to $446) less on medical care than did inactive persons in 1987. Adjusted to 1998 dollars, this figure is $564 (95% CI: $365 to $763) (Pratt et al., 2000).

In the National Medical Expenditure Survey, moderate physical activity was defined as spending at least 30 min in moderate or strenuous physical activity three or more times per week. It is assumed that all trail users met this criterion if they used the trails three or more times per week.

Cost-Benefit Ratios

A cost-benefit ratio was derived by dividing the direct medical cost saving by the total trail costs (construction, maintenance, equipment, and travel). The cost-benefit ratio shows how much health benefit can be achieved from a $1 investment in using a trail. If the ratio is larger than one, then using a trail is cost-beneficial. Otherwise, the return is less than the investment.

Sensitivity Analyses

Sensitivity analyses were conducted by worst- and best-case scenarios for several key parameters. For the costs of constructing and maintaining of the five trails included in the census report, the most and least expensive trails were used. Equipment and travel costs were ranged from $0 to $300 ($150 below or above the assumed average), the upper and lower bounds of the 95% CI of the direct health benefit were used, the life of trails was varied from the assumed average by 20 years, and the number of trail uses was varied by 50% from the actual number.

RESULTS

Among the five trails, the average construction cost per trail was $1.35 million (range: $0.95 million to $2.74 million). Allocated over a 30-year period, the average annual construction cost per trail was $44,949 (range: $3,184 to $91,334). Annual maintenance cost averaged $15,445 (range: $7,040 to $26,183). Together, the annual construction and maintenance costs averaged $60,494 per trail (range: $18,164 to $117,517) (Table 1).

During 1998, the trails were used an average of 225,351 person times (range: 58,035 to 597,870) (see Table 1). Average trail cost per use was $0.27 (range: $0.20 to $0.78).

The annual trail cost for a person to use a trail for 52 weeks, 3 times per week, and $0.27 each time is $52 \times 3 \times \$0.27 = \$42.12$. Then adding $150 for equipment and travel, the total annual cost per trail user rose to $\$42.12 + \$150 = \$192.12$. The annual direct health benefit of using the trail was $564.41 in 1998. Thus, the cost-benefit ratio was $\$564.41/\$192.12 = 2.94$, which means that every $1 investment in using trails led to $2.94 in direct medical benefit.

In all the sensitivity analyses, the cost-benefit ratio was larger than one (see Table 2). Even in the most sensitive worst-case scenario (high equipment cost), the direct medical benefit outweighed the cost by more than 65%.

DISCUSSION

The current study is the first, as far as we know, to report the economics of bike/pedestrian trails from a public health perspective. It is noticed that trail cost varied according to the surface type and length of the

TABLE 2
Cost-Benefit Ratios of Extreme Cases of Physical Activity Using Bike/Pedestrian Trails in 1998 (U.S. dollars)

	Worst-Case Scenarios		*Best-Case Scenarios*	
Variable	*Value*	*Cost-Benefit Ratio*	*Value*	*Cost-Benefit Ratio*
Cost of trail construction and maintenance	$0.78/use	2.08	$0.20/use	3.12
Equipment and travel cost	$300/year	1.65	$0/year	13.40
Direct health benefit	$365/year	1.90	$763/year	3.97
Life of trail	10 years	2.22	50 years	3.14
Number of trail users	50% below actual number	3.39	50% above actual number	3.63

trail. The least expensive of the five trails had a limestone chip surface with no bridges, and the most expensive trail had a concrete surface with two bridges. The wide variation in expenses makes building trails feasible across various communities (high-income or low-income, rural or urban areas). Local communities can build different types of trails according to their budget constraints.

The average trail cost per use, including construction and maintenance costs, was only $0.27. Even the most expensive trail was only $0.78 per use. This is substantially lower than most admission fees to health club facilities with exercise equipment, running tracks, and swimming pools. The number of uses rose with the length and quality of trails (surface type and number of bridges). This observation suggests that longer and more expensive trails may be more economically sound if more people use them, although other features may also stimulate people's interest in using trails (e.g., location, safety, and accessibility).

Of the total cost of using trails per person, less than 22% ($42 of $192) were building and maintaining expenses. Therefore, the major part of the cost was the cost of equipment and traveling to and from the trails. Furthermore, the cost-benefit ratio was most sensitive to the equipment and travel costs. Because these costs are an important factor affecting the use of trails and because trail users pay these costs out of their own pockets, enhancing awareness of the health benefits of physical activity among residents should be an important component in public health intervention programs.

The cost-benefit ratio appeared not sensitive to the total annual trail cost and the number of years the trail could be used. Even for the most expensive trail and the shortest life period, a $1 investment resulted in about a $2 return. This finding indicates that as long as a trail can be used for 10 years or more, the benefit will outweigh the investment.

The estimates of cost-benefit ratios are conservative because only direct medical benefits among people without physical limitations were included; however, all trail costs (construction, maintenance, equipment, and travel) were included. Physical activity will also yield indirect benefits to trail users, such as increased quality of life and psychological well-being. In fact, the current trails were built as part of the community development planning. The main purpose of building these trails was not for health promotion or reduction of health care costs. Therefore, the health benefit used for the analysis was a component of the trail benefits. In addition, if the national sample for the analysis of medical costs included people with physical limitations, the direct health benefit should be even bigger, which is in favor of a larger cost-benefit ratio.

Several limitations should be mentioned. First, the trail cost and use information were based on five trails. The sample is too small to furnish a vigorous quantitative analysis, so the representativeness of the cost and use data is limited. The cost of construction and maintenance of trails is believed to vary greatly across communities. In addition, certain trail information (e.g., quality of maintenance, appropriateness of joint use by walkers and cyclists, and design of pedestrian crossings) is lacking. The second limitation is that although the direct medical benefit is from a nationally representative sample, the definition of physical activity may not be comparable with the physical activity level obtained by using trails. Using the trails three times a week was used as a measure of moderate physical activity, which may not be comparable with the physical activity measure in the National Medical Expenditure Survey. Furthermore, the direct medical benefit was derived from a national sample of people 15 years of age or older; no information on the age of the trail users was available. Finally, findings of this research should be interpreted as estimates under the assumption that people were using trails for the health benefits of physical activity. Because there is a lack of information about changes in physical activity behavior of the trail users, the impact of trails on health promotion cannot be evaluated using more advanced models such as transtheoretical models (Mettler, Stone, Herrick, & Klein, 2000). Therefore, the cost-effectiveness of the trails in promoting physical activity cannot be claimed. Future research should focus on comprehensive data collection efforts. In addition to the cost information presented in the current study, behavioral and health information of trail users are needed for conducting comprehensive cost-effectiveness studies. These studies will certainly aid policy makers in making informed decisions in resource allocations. Clearly, more data and other methods are needed in this regard.

Several strengths of the current study should also be mentioned. First, actual construction and maintenance cost data for five trails were used. The five trails vary in surface types, length, and number of bridges. Although the results may not be generalized to the nation, the variety of the trails covered in the current study should enhance the generality at the local community level. Second, all the direct costs and direct benefits were converted to a per capita basis. Therefore, the costs and benefits were comparable and an economic measure cost-benefit ratio could be derived. Finally, sensitivity analyses for all the five key parameters were conducted. The ranges of the parameters may be wide enough to cover all the possible situations.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

To promote physical activity at population level presents a public health challenge. Building environments that are more favorable to physical activity should facilitate the promotion. In fact, interventions that attempt to change the environments to create opportunities for physical activity have been strongly recommended (Task Force on Community Preventive Services, 2002). However, a potential barrier of creating the opportunities is that building such environments is resource intensive (Kahn et al., 2002). The current study demonstrated that building bike/pedestrian trails might fit a wide range of budget situations facing communities.

The cost-benefit information presented in the current study provides evidence that building bike/pedestrian trails may be cost-beneficial. The resource expenses on using the trails may be outweighed by the direct health benefits alone. Moreover, the results show that the construction and maintenance costs per use are low, and the direct medical benefit of using trails is nearly three times as high as the direct cost. Building trails may be a cost-effective means for physical activity promotion at the community level. This information should be useful to policy makers and community organizations for decisions in implementing such interventions.

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