



Reducing injuries among Native Americans: five cost-outcome analyses

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Abstract

This paper presents cost-outcome analyses of five injury prevention efforts in Native American jurisdictions: a safety-belt program, a streetlight project, a livestock control project, a drowning prevention program, and a suicide prevention and intervention program. Pre- and post-intervention data were analyzed to estimate projects' impact on injury reduction. Projects' costs were amortized over the time period covered by the evaluation or over the useful life of physical capital invested. Projects' savings were calculated based on estimated reduction in medical and public program expenses, on estimated decrease in lost productivity, and on estimated quality adjusted life years saved.

All projects yielded positive benefit-cost ratios. The net cost per quality adjusted life years was less than zero (i.e. the monetary savings exceeded project costs) for all but one of the projects.

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1. Introduction

Reservations and trust lands are home to 900,000 Native Americans. Injuries are second only to heart disease as a cause of death for their residents (Indian Health Service, 1998) and the second largest source of hospital days. Tribal governments, aided by the Indian Health Service (IHS), are responsible for preventive and restorative health services for these populations. They have launched many injury prevention projects.

An important policy question is whether cost-effective injury prevention can be implemented for the sparsely populated frontiers in Native American territories. To address that issue, this paper analyzes the return on investment for five of the prevention projects: a safety-belt program, a streetlight project, a livestock control project, a drowning prevention program, and a suicide prevention and intervention program. Data availability was the deciding factor in project selection. Each analysis describes costs of program implementation and operation, program effectiveness, and the related cost savings.

A review of 84 cost-outcome analyses of US injury prevention efforts was unable to locate any analyses of drowning, suicide, or adult pedestrian injury prevention (Miller and Levy, 2000). The world literature does not appear to contain economic analyses of these interventions either. Nor are there prior analyses of the cost savings resulting from safety interventions in Native America or from a primary safety-belt use law in a largely subsistence economy. Indeed, other than an early report on the impact of the Navajo Nation's belt law (Centers for Disease Control, 1995) only one evaluation of a safety-belt use law in a less developed agrarian country (South Africa) has been published (Botha et al., 1996). Thus, this paper may provide insights for countries like Jamaica, The Philippines, and Thailand that have recently passed and not yet evaluated belt use laws.

1.1. The safety-belt program

The Navajo Nation comprises parts of Arizona, New Mexico, and Utah, with a land area comparable to the state of West Virginia and a population close to 200,000. In 1988, it enacted a law requiring automobile drivers and passengers to wear safety-belts. The law permitted officers to stop

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vehicles for a safety-belt use violation alone, unlike in most US states and tribes, where a vehicle must first be stopped for some other traffic violation. The transition period between passage of the law and full enforcement saw an intensive public information campaign promoting the new law and the benefits of safety-belt use.

1.2. *The streetlight project*

In November 1988, the Eastern Arizona District of the IHS's Office of Environmental Health and the White Mountain Apache Tribe (population 10,000) installed 28 streetlights along a 1.1-mile section of highway to reduce pedestrian injuries, primarily to intoxicated victims, in Whiteriver, Arizona. The project also involved the State Transportation Department and the local electric utility.

1.3. *The livestock control project*

In 1991, after weaker regulatory efforts failed, the Tribal Council of the White Mountain Apache Tribe established a Livestock Control Project with authority to impound free-roaming livestock on reservation roads.

1.4. *The drowning prevention program*

In 1991, the Yukon Kuskokwim Health Corporation launched a project aimed at reducing the number of drowning deaths in Alaska's Yukon and Kuskokwim rivers, which serve as the primary source of transportation for the 22,000 local residents by boat in the summer and by snowmobile in the winter. In addition to swimming and water survival courses, this project offered summer-weight coats that doubled as personal floatation devices (float coats). These buoyant coats are designed to keep a conscious or unconscious person afloat and to reduce the onset of hypothermia, which is a significant factor in drowning deaths in Alaska even during the summer. The coats were sold at wholesale prices, which made them comparable in price to non-buoyant coats. Several colors and styles were offered.

The float coat program was successful, primarily because the coats were sold as inexpensive, warm, comfortable outerwear, not as safety items. Selling float coats as safety devices would have been unsuccessful because of the strong local belief that anyone who fell in the water would certainly die from cold temperatures. The fact that modern motorized vehicles are powerful enough to get a victim to warmth in time to survive was not widely accepted. To sell the floating properties of the coats to the public, tribal elders suggested a culturally appropriate marketing message: "Wear a float coat so that if you drown, people will not have to drag the river for your body." This message resonated strongly with communities accustomed to hours and days of uncertainty surrounding most drownings. Everyone helped drag the river several times a year to retrieve drowning victims.

Many people began to purchase buoyant coats, usually when their regular coats and jackets wore out. An aggressive public education campaign, increased availability of float coats, and better enforcement of boating laws on the rivers paid off. Today, almost everyone rides the river in a float coat.

1.5. *The suicide prevention and intervention program*

In January 1990, following concern about increasing suicide rates among youth, a Western Athabaskan tribe in rural New Mexico implemented a suicide prevention and intervention program that targeted tribal members aged 15–19 years, while serving the entire tribe. The tribal mental health program was the program's backbone. Before 1990, that program consisted of a mental health technician, a psychologist for 2 days a week, and monthly consultations by an IHS psychiatrist. To implement the suicide prevention program, the tribe hired a social worker who devoted 80% of her time to youth suicide prevention and the remainder to developing program infrastructure. A school-based "natural helpers" component, started in 1990, trained 10–25 youth per year to respond to young persons in crisis and notify mental health professionals of the need for assistance. Prevention of alcohol abuse, child abuse, and violence between intimate partners was included because these behaviors were associated with suicide. Other components included outreach to families after a suicide or traumatic death or injury, immediate response and follow-up for reporting at-risk-youth, community education about suicide prevention, and suicide-risk screening in mental health and social service programs.

2. **Methods**

This study is intended to add new cost-outcome estimates to the literature, not to advance methods for cost-outcome analysis or injury costing. Therefore, it follows the reference case guidance prescribed by the Panel on Cost-Effectiveness in Health and Medicine (PCEHM) (Gold et al., 1996) to develop and present its cost-outcome estimates. Notably, in the reference case, a 3% discount rate must be used to compute the present value of future costs and benefits. "The PCEHM reference case provides an explicit and well-justified set of rules for conducting and reporting cost-effectiveness studies in a manner that allows the results of different studies to be compared with one another." (Carande-Kulis et al., 2000) This study also adheres to the guidelines for cost-effectiveness analysis in Udvarhelyi et al. (1992). It precisely follows the reference-case cost-outcome (cost-effectiveness and cost-benefit) analysis methods and injury costing methods described in Miller and Levy (1997, 2000) in order to create estimates comparable to their cost-outcome estimates for 84 injury prevention measures.

The cost-effectiveness analyses examine net cost per quality adjusted life year (QALY) saved. The net cost of a project

is calculated by subtracting medical and other out-of-pocket cost savings from the total cost of the project. To avoid double counting, work loss, which is incorporated in the QALY measure, was not also counted in net costs. If the dollar savings exceed project costs, the project offers net cost savings. A QALY is a health outcome measure that assigns a value of 1 to a year of perfect health and 0 to death (Gold et al., 1996). For fatalities, the QALYs equal the years of expected life lost discounted to present value. For non-fatal injuries, we used diagnosis-specific QALY estimates from the Databook on Non-fatal Injury (Miller et al., 1995). Their estimates were computed in three steps. First, physicians rated the typical observable losses over time for victims of every injury diagnosis catalogued in a common diagnosis system. The ratings covered six dimensions: bending/grasping/lifting, cognitive, mobility, sensory, cosmetic, and pain. Second, data were added about the probability of permanent work-related disability by diagnosis. Third, with values for different functional losses from preference-based surveys of the general population (Torrance, 1982; Kaplan, 1982) the observable losses were converted into an estimated percentage loss in quality of life measured on a QALY scale.

The cost-benefit analyses compared total cost savings with total project costs by placing a dollar value on the QALYs saved. Both US regulatory benefit-cost guidelines (US Office of Management and Budget (OMB) 1989) and standard economic texts on benefit-cost analysis (Boardman et al., 1996; Mishan, 1988) prescribe using the willingness to pay approach to value mortality and morbidity risk reductions. Thus, we applied a mean value per QALY of US\$ 88,600 derived from a systematic review of almost 50 studies of what people pay to reduce health and injury risks (Miller, 1990). We followed a societal approach in our cost-benefit analyses. Benefits included cost savings to individuals, local governments, insurance companies, employers, and the general public. Costs were limited to the agencies implementing each program.

2.1. Data

2.1.1. The safety-belt program

This study analyzed deaths and hospitalizations resulting from injuries sustained by automobile occupants in highway crashes (International Classification of Diseases, Ninth Revision, Clinical Modification, external cause-of-injury codes E810–E817 and E819, with four digits of 0, 1, 8, or 9). Injury counts and costs were compared for three periods: before passage of the law (1985–87); after passage of the law but before enforcement (1988–90); and after enforcement began (1991–95). The Centers for Disease Control and Prevention (CDC) provided IHS Vital Statistics and hospital discharge data (Indian Health Service, 1995). These data include all hospitalizations for injuries to American Indian residents of the Navajo Nation, whether admitted to hospitals run directly by the IHS or to contract hospitals. They describe the cause, diagnosis, body region, and severity of

the injury; length of stay; discharge destination; and demographic and geographic factors.

2.1.2. The streetlight project

To measure the yearly reduction of motor vehicle–pedestrian crashes resulting from the streetlights, IHS staff reviewed all police-reported crashes logged by the Whiteriver Police Department on the highway section where the streetlights were installed. The period covered was calendar years 1984–1993 (before intervention: 1984–88; after intervention: 1989–93). Hospital discharge data were not used in the analysis, because they do not identify where crashes occurred.

2.1.3. The livestock control project

The livestock-crash case study reviewed all reported motor vehicle crashes logged by the Whiteriver Police Department on reservation roadways and within the boundaries of the Fort Apache Indian reservation. It compared the number of motor vehicle–livestock crashes occurring before (January 1987 to August 1991) and after (September 1991 to December 1994) the implementation of the livestock project, controlling for non-livestock crashes. The police also provided the number of livestock impounded, and the project's disposition of livestock (owner bail-out versus voluntary forfeit).

To control for traffic volume when estimating the change in the number of crashes before and after the intervention, the number of vehicles passing six roadway mileposts was ascertained by the Arizona Department of Transportation. In absence of data on vehicle-miles traveled, the vehicle counts were used as a proxy for traffic volume on reservation roads during the study period.

2.1.4. The drowning prevention program

The evaluation relied on 1983–1996 drowning death data provided by the Yukon Kuskokwim Health Corporation (before intervention: 1983–90; after intervention: 1991–96). To control for drowning death trends among the rest of the Native Alaskan population, drowning deaths were retrieved from CDC's Web-based Injury Statistics Query and Reporting System (WISQARS).

2.1.5. The suicide prevention and intervention program

This case study was built from a CDC program evaluation (DeBruyn et al., 1998). To evaluate the program's effectiveness, a surveillance form was developed and used by local professional staff to collect information about suicide completions and attempts. Program staff assessed all persons who made suicide attempts between 1990 and 1997, and obtained extensive demographic information about persons who committed a suicidal act. Data from 1988 to 1998 were gathered from police, medical, and mental health program records. Data on suicide acts before 1988 were incomplete and excluded from analysis. Information about suicide completions came from police records, health clinic records,

tribal emergency service records, and family and community members. The trend of youth suicide acts over time was analyzed and also compared to the trend in adult suicide acts not specifically targeted by the program.

2.2. Project costs

Most project costs were extracted from IHS and tribal records. The initial costs of the primary belt use law were US\$ 65,000 in administrative costs of passing the law and implementing it, which were concentrated during 1988–90. Costs of US\$ 221,000 related to publicity and police overtime pay and other incentives to enforce the law were distributed evenly from 1991 to 1994. The annual costs for the primary safety-belt use law, streetlight, and livestock projects were calculated by annualizing the one-time initial costs and adding the yearly operating costs. In amortization calculations, we used an experience-based 12-year life for the US\$ 10,000 impound truck and a 15-year life for the streetlights (Miller et al., 1985), which cost US\$ 1000 each. The safety-belt law start-up costs were amortized over the period covered by the evaluation. We amortized with a discount rate of 3% and inflated operating expenses to 1998 dollars using the Consumer Price Index (CPI)—All Items.

The drowning prevention program operating cost was essentially zero because the float coats served as all-purpose coats for inhabitants of the Yukon and Kuskokwim delta and cost no more than other coats. The program started with a US\$ 10,000 IHS grant. Once started, it was self-financing. The proceeds from the sale of a coat were used to purchase another. Health Coalition injury prevention staff sell the coats and maintain the inventory.

The suicide prevention program funding came from IHS grants, including US\$ 75,000 from 1990 to 1991, US\$ 125,000 from 1992 to 1993, and US\$ 195,000 from 1994. However, the program served the entire tribal community. Cost percentages of staff time, salary, and educational efforts targeting 15–19 year olds were estimated and used for the present analysis. Following 1994, direct monies for suicide prevention ceased, and the program was incorporated into tribal mental health and behavioral health program components.

2.3. Cost savings

To compute cost-savings, these case studies adapted existing peer-reviewed injury costs rather than developing costs. For the safety-belt analysis, costs per fatality and per hospital-admitted highway crash survivor by injury severity and body region injured were updated from prior studies (Miller, 1993; Miller et al., 1995), with published procedures (Miller et al., 1998), then adjusted to reservation prices and wages. The costs of an injury include direct payments for medical care, emergency services, and legal and administrative costs; lost work; and reduced quality of life.

The earlier studies computed medical costs for hospitalized crash injuries from lengths of stay in NHTSA's National Accident Sampling System (NASS) and medical payments per day (including a *pro rata* share of professional fees, rehabilitation, prescriptions, and multi-year follow-up care) from the National Council on Compensation Insurance's Detailed Claims Information (DCI) longitudinal file for 1979–88. These costs were inflated to 1998 dollars using a medical spending per capita index and adjusted to Navajo Area costs using the ACCRA area medical price indices (Bureau of the Census, 1999). Emergency services costs were inflated with the CPI—All Items from costs modeled with NASS data on utilization and national data on costs per unit of ambulance, police, and fire service. Administrative and legal costs associated with compensating medical and productivity losses were computed as a percentage of losses from national statistics on insurance loss adjustment expenses and national studies of litigation about highway crashes (Kakalik and Pace, 1986; Hensler et al., 1991).

Lost work includes wages, fringe benefits, and housework lost by the injured, as well as productivity lost by employers who must recruit and train replacements for disabled workers. NASS provides information on work days lost. Probabilities of permanent disability by diagnosis were computed from DCI and NASS data. To compute victim work losses, this information was combined with the victim age–sex profile in the IHS data and earnings data for the Navajo reservation. The costs to employers are a minor cost factor that builds heavily on assumptions; they were inflated from the prior estimates with the Employment Cost Index (Council of Economic Advisers, 1998).

Reduced quality of life includes the good health lost and the pain and suffering resulting from an injury. For fatalities, it equals the years of expected lifespan lost. For non-fatal injuries, it was computed from physician estimates of functional capacity losses by injury diagnosis (Miller, 1993; Miller et al., 1995), translated into QALY losses with survey data used by NHTSA in regulatory analysis of highway safety interventions (Torrance, 1982; Kaplan, 1982).

Similar methods were used in analyzing cost savings from the streetlight, and livestock crash projects. Travel delays and property damage were additional cost saving categories included in the streetlight project analysis. In the livestock crash analysis, travel delays were considered to be negligible, given the widespread practice in Indian reservations of driving off-road. The original costs (Miller et al., 1998) did not include the cost of livestock killed in the crashes; therefore, we added them in our costs. About 80% of livestock killed in crashes were horses; we conservatively assumed that the remaining 20% were sheep and pigs. Horses saved with the intervention were valued using the sales prices of impounded horses not claimed by their owners. Sheep and pig prices were found in the Statistical Abstract of the US (Bureau of the Census, 1999) and adjusted to Fort Apache area costs using the ACCRA composite adjusters.

The drowning deaths, suicide deaths, and non-fatal youth suicide acts prevented were valued with the injury costs developed by Miller et al. (2000) and adjusted to local conditions using ACCRA price indices and earnings data for respective tribes. The personal income data were found on the US Census web site. The costs saved include medical, work loss, and quality of life.

3. Results

3.1. The safety-belt program

Between 1988 and 1991, the prevalence of safety-belt use in the Navajo Nation increased from 14 to 60% (Bureau of the Census, 1999). In the 3 years before the safety-belt law passed, injuries to motor vehicle occupants averaged 428 annually, monetized costs US\$ 64.8 million, and QALY losses 639 (Table 1). These annual figures fell by 41 injuries (10%), US\$ 5.3 million (8.2%), and 121 QALYs (19%), respectively, in the 3 years after the law passed (1988–90), and by another 80 injuries (19%), US\$ 9.7 million (15%), and 109 QALYs (17%) after enforcement began (1991–1995). Cost savings from this program totaled US\$ 11.4 million per year. Using project cost figures and methods presented in Section 2.2, we estimated that the annualized cost of running the program was US\$ 44,600. Thus, the benefit-cost ratio was 256. The program offered net cost savings.

3.2. The streetlight project

In the 59 months before the streetlight intervention project, 15 pedestrian crashes happened along the 1.1-mile section of highway targeted by the intervention. Only three such crashes occurred in the 61 months after the intervention. The average reduction of 2.46 pedestrian crashes per year (80%) resulted in a gross annual intervention saving of US\$ 97,000 (Table 2). After subtracting the amortized initial investment value of US\$ 2500 and the annual operating cost of US\$ 7142 for electricity, bulbs, etc. the net annual

Table 2

Cost per crash and gross annual savings^a from the reduction of pedestrian crashes, Whiteriver, AZ, 1984–1993

Cost categories	Average cost per crash	Annual savings
Medical (US\$)	11167	27478
Public programs (US\$)	239	589
Work loss (US\$)	3766	9267
Employer costs (US\$)	241	592
Travel delay (US\$)	107	264
Property damage (US\$)	4298	10576
Quality of life (US\$)	19667	48394
Total (US\$)	39485	97161
Quality-adjusted life years	0.64	1.57

^a In 1998 dollars.

intervention saving was US\$ 87,500. The benefit-cost ratio was 10 with net cost savings.

3.3. The livestock control project

Between January 1987 and November 1991, when livestock regulations were not enforced in the White Mountain Apache reservation, the police department registered an average of 27.6 livestock crashes per year (Table 3). From August 1991 to December 1994, when livestock regulations were enforced, the average annual number of crashes was reduced to 9.3 (a 66% reduction). During the same period, the average annual number of non-livestock crashes increased by 7.5%, because traffic volume grew during these years. The number of non-livestock crashes per million vehicles passing six roadway mileposts within the boundaries of the reservation dropped by 9%, compared to a 71% reduction for livestock. Linear regressions on monthly crash rates suggested that this reduction was mainly explained by the intervention ($P = 0.000$, $R^2 = 0.92$). The control variable (non-livestock crash rate) was insignificant ($P = 0.76$).

The gross annual saving from this intervention was almost US\$ 63,000 (Table 4). After subtracting the amortized initial investment value of US\$ 1000 and the annual operating cost of US\$ 36,000 for gas, salaries, etc. the net annual

Table 1

Costs^a before and after passage and enforcement of primary safety-belt law, Navajo Nation, 1985–1995

	No safety-belt law 1985–87	Safety-belt law passed 1988–90	Safety-belt law enforced 1991–95
Monetized Costs ^b (US\$)	64804	59465	49731
Medical	16909	14181	10395
Work loss	27886	29029	26486
Public programs	261	247	210
Quality of life	19748	16008	12640
Annual Savings	NA	5339	15073
Quality adjusted life years	639	518	409
Annual Savings	NA	121	230

^a For fatal and hospitalized injuries.

^b In thousands of 1998 dollars.

Table 3
Crash ratios before/after livestock regulation enforcement, Fort Apache reservation, 1987–1994

	Non-livestock crashes	Livestock crashes	Vehicles observed	Non-livestock crash ratio (per million vehicles)	Livestock crash ratio (per million vehicles)
Before enforcement					
1987	314	24	8792850	35.71	2.73
1988	223	31	9964500	22.38	3.11
1989	218	36	10037500	21.72	3.59
1990	165	29	8953450	18.43	3.24
1991 (January–October)	79	9	5702891	13.85	1.58
Total	999	129	43451191	22.99	2.97
Annual average	214.1	27.6	9310970	22.99	2.97
After enforcement					
1991 (November–December)	52	2	3157739	16.47	0.63
1992	208	7	9588550	21.69	0.73
1993	245	12	9588550	25.55	1.25
1994	262	10	9588550	27.32	1.04
Total	767	31	31923389	24.03	0.97
Annual average	230.1	9.3	9577017	24.03	0.97

intervention saving was US\$ 25,000. The benefit-cost ratio was 1.67 with net cost savings.

3.4. The drowning prevention program

During 1991–1996, the average drowning death rate in the Yukon and Kuskokwim delta was reduced by 53% ($P = 0.004$) compared to the pre-intervention period. Since the program started, the majority of the drownings now are snow-machine related (the program targeted drowning associated with boating activities).

The trend of drowning death rates for the Yukon and Kuskokwim delta was not correlated with the respective trend for the rest of the Native Alaskan population ($P = 0.956$). Fig. 1 illustrates linear regression results.

The reduction in drowning was achieved at minimal cost because the float coats were serving as all-purpose warm-weather coats for the inhabitants of Yukon and Kuskokwim delta. In addition to saving 3898 QALYs

between 1991 and 1996, the project reduced the time and expenses associated with searching for the bodies of drowning victims. These savings were estimated conservatively at 10 person-days or US\$ 420 per case; in reality, some drownings require professional divers to recover the bodies.

Annual economic cost savings from the intervention totaled US\$ 1.2 million. Monetized yearly quality of life savings totaled US\$ 3.6 million. The benefit-cost ratio was 2592, with net cost savings.

3.5. The suicide prevention and intervention program

During 1988–1989 (i.e. before program implementation), the average suicidal act rate for persons aged 15–19 years was 59.8 ($n = 34$) per 1000 population, compared with 7.5 ($n = 38$) per 1000 for all other age groups. In the first two years of the intervention (1990–1991), the rate for persons aged 15–19 years decreased to 8.9 ($n = 5$) per 1000 population; this rate increased slightly to 9.2 ($n = 5$) during 1992–1993, rose to 17.6 ($n = 10$) during 1994–1995, and decreased to 10.9 ($n = 7$) during 1996–1997. Although rates varied after the implementation of the program, they remained substantially lower than before the program was initiated. Rates for ages 20 and over declined slightly between 1988 and 1997 (Fig. 2).

During 1990–1997, 13.38 less suicidal acts were committed annually than during 1988–1989. Fatal cases dropped 0.25 per year and medically treated non-fatal cases dropped 6.88 per year. Medical and other economic cost savings from the intervention totaled US\$ 123,000 annually. Monetized quality of life savings totaled US\$ 1.7 million annually. The benefit-cost ratio was 43 and the cost per QALY saved was US\$ 419.

Table 4
Cost per crash and gross annual savings^a from the reduction of livestock crashes, Fort Apache reservation, 1987–1994

Cost categories	Average cost per crash	Annual savings
Medical (US\$)	148	2707
Public programs (US\$)	54	985
Work loss (US\$)	196	3587
Employer costs (US\$)	24	439
Property damage (US\$)	2754	50523
Quality of life (US\$)	240	4408
Total (US\$)	3415	62649
Quality-adjusted life years	0.0076	0.14

^a In 1998 dollars.

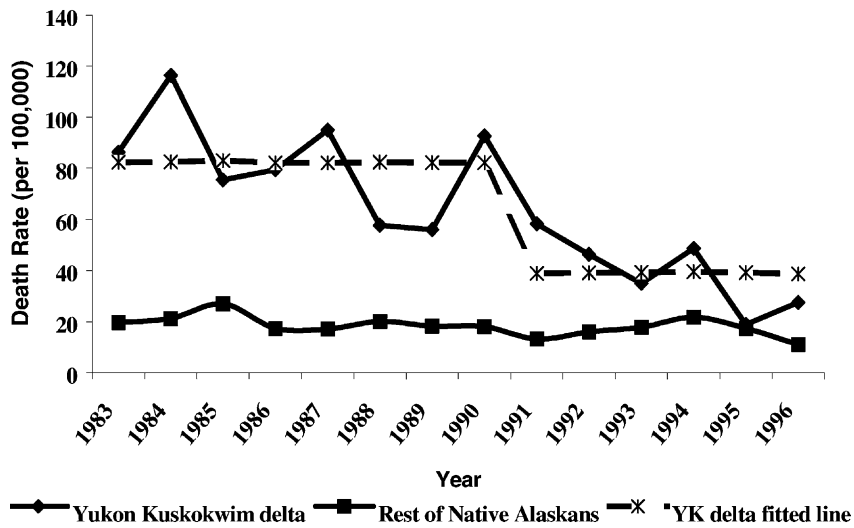


Fig. 1. Drowning death rates for Yukon–Kuskokwim Delta residents versus other Native Alaskans, 1983–1996, with intervention in 1990.

3.6. Summary of results

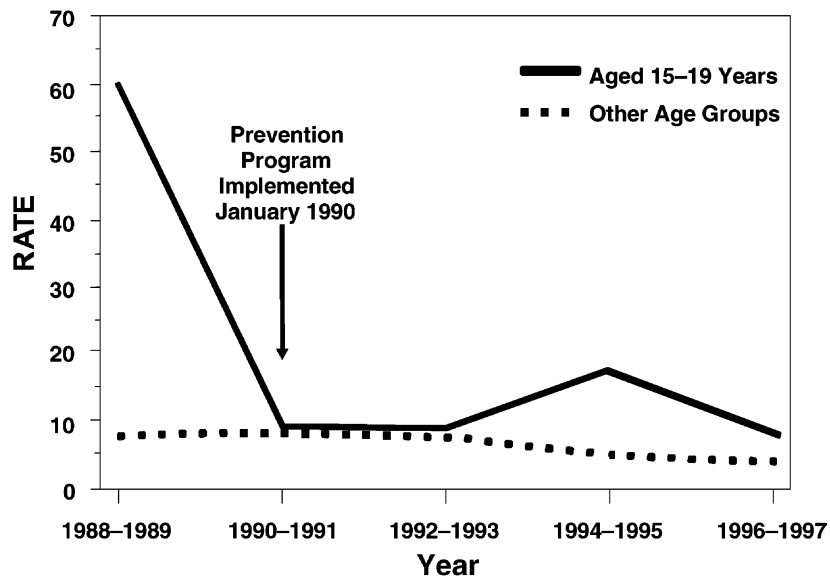
Table 5 summarizes the cost–outcome analysis results using the same format that Miller and Levy (2000) used for 84 interventions. Their review included 33 road safety measures. Like the three road safety interventions analyzed here, 19 of those interventions yielded net cost savings.

Miller and Levy were unable to locate any US cost–outcome analyses of either drowning or suicide prevention. The studies reported here are the first on these issues. In both cases, the cost per QALY saved is impressively low. These

interventions would rank in the lowest quartile of cost per life saved in a broader review of 500 life-saving interventions (Tengs et al., 1995). Accounting for the quality of life saved, the return on investment for these interventions is among the largest for any of the 84 interventions that Miller and Levy (2000) reviewed.

3.7. Sensitivity analysis

A sensitivity analysis on the cost–outcome results was especially important for the belt law and streetlight programs,



^aPer 1000 population. Includes suicidal attempts and completions.

^bRates calculated in 2-year intervals for rate stability.

Source: DeBruyn et al.

Fig. 2. Rates of suicidal acts^a for persons aged 15–19 years compared with persons of all other ages, Western Athabaskan Tribe, 1988–1997^b.

Table 5
Summary of the cost-outcome analyses

Intervention	Annual cost per unit (US\$)	Annual medical savings per unit (US\$)	Annual other economic savings per unit (US\$)	Annual quality of life savings per unit (US\$)	Benefit-cost ratio	Net cost per QALY (US\$)
Safety-belt law	0.26/person	39/person	30/person	35/person	256	<0
Streetlight project	345/light	980/light	759/light	1728/light	10	<0
Livestock project	6.5/driver ^a	0.5/driver ^a	9.6/driver ^a	0.8/driver ^a	1.7	<0
Drowning program	0.09/person	0.00/person	60/person	175/person	2592	<0
Suicide prevention	151/youth	38/youth	1035/youth	6041/youth	43	419

^a All people over age 18 were considered potential drivers.

since unavailability of comparison groups makes their effectiveness/benefit estimates tenuous. Fortunately the results are not very sensitive to these estimates. The benefit-cost ratios vary linearly with effectiveness meaning the livestock project returns savings exceeding its costs if effectiveness is at least 59% of the best estimate, while all the other interventions yield savings at even 50% of their best estimates or if costs were double those observed. Even with a 50% drop in effectiveness or a doubling of program cost, three projects yield net cost savings and the suicide program costs US\$ <1000 per QALY saved. The livestock project yields net cost savings with a 33% effectiveness reduction or cost increase, then rapidly increases in cost per QALY. That project had a good comparison group, so such a large effectiveness misestimation is unlikely.

4. Discussion

Any of the effectiveness estimates could have been affected by changes in the safety environment. For example, in the Yukon and Kuskokwim delta case study, the outcome analysis accounted for the trend in drowning death rates for the rest of Alaska Natives. However, if drinking patterns among delta residents changed, that could influence the outcome. In estimating intervention impacts in the Navajo case study, we ignored the safety impacts of routine annual highway improvement projects. Accounting for those projects might marginally reduce the estimated impact of the seatbelt law. Similarly, in the streetlight case study, any changes in drunk driving or speed control could have influenced pedestrian crashes. However, we found no information suggesting such changes occurred.

The suicide prevention analysis bears further caveats. With pre-intervention data being limited, the possibility that high suicide rates during 1998–99 were an anomaly cannot be excluded. The cost-outcome analysis is based on monies spent on youth suicide intervention and prevention only. This program served all members in a small tribe with a centralized population and, over time, created a system of care that included suicide prevention as a main component. Without all components of a comprehensive system of mental health care and education prevention for the entire community, it is questionable whether the youth suicide prevention component analyzed for the purposes of

this paper would have been as successful. In other words, other costs for program components indirectly related to suicide prevention, although not included in this analysis, must be considered when developing a youth suicide prevention program in an undeserved community. Anecdotal evidence suggests that, in addition to the aforementioned indirect benefits, those components added direct benefits to society by reducing substance abuse and domestic violence (Serna, 2000, personal communication). A broader study is needed that rigorously evaluates all program components.

An important lesson from the drowning prevention case is that interventions that address individual behavior and decision making should be sold within a cultural context. Often the question is not whether something will work but how to influence behavior. A second example of this lesson comes from the Navajo Nation where a prenatal child safety seat giveaway program had a negligible impact on seat use. Investigation revealed that Navajos feel it brings bad luck to get things for a baby prenatally. Once distribution shifted postpartum, usage jumped.

Injury prevention clearly has been an excellent investment for Native American tribes, Alaska Native Tribal Health Consortium, and the IHS. It has saved money while saving lives. These successes suggest that injury prevention efforts can be cost-effective in sparse frontier population that face high injury risks.

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