A Cost–Benefit Analysis of Legislation for Bicycle Safety Helmets in Israel

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A B S T R A C T

Legislation requiring bicyclists to wear helmets in Israel will, over a helmet's 5-year duration (assuming 85% compliancy, 83.2% helmet efficiency for morbidity, and 70% helmet efficiency for mortality), save approximately 57 lives and result in approximately 2544 fewer hospitalizations; 13 355 and 26 634 fewer emergency room and ambulatory visits, respectively; and 832 and 115 fewer short-term and long-term rehabilitation cases, respectively. Total benefits ($60.7 million) from reductions in health service use ($44.2 million), work absences ($7.5 million), and mortality ($8.9 million) would exceed program costs ($20.1 million), resulting in a benefit–cost ratio of 3.01:1. (*Am J Public Health.* 1994;84:653–656)

Introduction

Almost all bicycle accident mortality results from head and brain damage,[1–5] and nonfatal head injuries sometimes result in victims requiring expensive, lifelong care for their disabilities.[6–11] Between 70.9% and 95.5% of head injuries and about 70% of fatalities involving head injuries could be prevented through the use of crash helmets.[12–21] Fewer than 2% of Israel's estimated 833 000 cyclists[22] currently use such helmets.[11,23]

During the period from 1967 to 1991,[24] accidents to bicyclists accounted for annual mortality, hospitalization,[23] and emergency room visitation rates of 5.02, 228.5, and 2262.4 per million, respectively,[24] after adjustment for the estimated 88.9% (95% confidence interval [CI] = 87.7%, 90.1%) underreporting of emergency room cases.[23,25] Hospitalization rates were stable throughout this period, while mortality rates decreased between 1975 and 1980 and then stabilized. Persons under 20 years old accounted for 57.0% of hospitalizations, and older individuals had higher case fatality rates[24] (Table 1).

This paper estimates the costs and benefits from expected reductions in mortality and morbidity if mandatory bicycle helmet use legislation were enacted in Israel.

Methods

Direct (i.e., including only health service benefits) and total (direct, work, and mortality) or societal benefit–cost ratios based on the parameters in Table 2 were calculated on a spreadsheet; a 5% per annum discount rate was used. Lifetime costs of premature mortality, institutional care, and special education were discounted and attributed to the year in which the accident occurred.

The 85% compliancy rate (see Table 2) is based on Israelis' 90% compliancy with car seat belt laws,[26] only 6% less than the 96% achieved for bicycle helmet use after legislation in Melbourne, Australia.[21]

The gross national product per capita method of valuing life,[27] which assigns an equal value to each member of society equivalent to the annual per-capita gross national product of the population ($10 728 in 1990), was used to estimate mortality costs. These costs were based on discounting the value of the deceased's expected years of life lost.

Results

In 1994, bicycle-related injuries will account for approximately 26.5 deaths, 1203 hospitalizations, and 11 913 persons requiring emergency room treatment.

The cost of crash helmets (current retail price: $23.40) for Israel's 833 000 cyclists would be $19.5 million. An additional $607 000 would be required over 5 years for health education purposes.

Legislation for bicycle helmet use in Israel would, over a helmet's 5-year duration,[28] prevent approximately 57 deaths. Also, it would result in 2544 fewer hospitalizations, 13 355 fewer emergency room visits, 26 634 fewer ambulatory visits, and 832 and 115 fewer short- and long-term rehabilitation cases (including 45 children needing special education), respectively (Table 3).

The direct benefit ($44.20 million) to cost ($20.14 million) ratio is 2.19:1. When benefits from reductions in work absences ($7.55 million) are included, the benefit–cost ratio rises to 2.57:1. After adding benefits from reductions in mortality ($8.94 million), the total benefit–cost ratio to society rises to 3.01:1 (Table 3).

Sensitivity analyses available upon request from the authors show the benefit–cost ratio to be sensitive to

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TABLE 1—Deaths, Hospitalizations, and Light Injuries from Bicycle Injuries, by Age: 1979 through 1990, Israel

Age, y	Deaths (n = 184), %	Hospitalizations (n = 2177), %	Light Injuries (n = 9071), %
0–4	0.5	1.0	0.9
5–9	9.2	12.6	8.0
10–14	14.7	25.6	22.1
15–19	12.0	17.8	19.7
20–24	2.7	6.3	7.6
25–34	8.2	7.1	10.5
35–44	7.6	5.5	7.5
45–54	10.9	7.4	7.2
55–64	12.5	7.1	7.9
65+	21.7	9.5	8.7
Total	100.0	100.0	100.0

TABLE 2—Parameters Used in Cost–Benefit Analysis

	Parameter	Source
Israeli population (1992)	5 266 000	(Reference no). 42
Per capita gross national product, $	10 728	43
Average annual wage costs, $	14 338	43
Average income of person in bicycle accident, $	5 519	Calculations on ref 24
Unemployment (1992), %	12.0	42
Male accident victims, %	87.0	24
Helmet cost, $	23.40	Retailers
Health education costs (5 years), $	607 000	Ministry of Health
Bicycle ownership rate, %	8.55	22
Riders per bike	1.85	22
Duration of helmet life, y	5	28
Initial compliancy, %	2.00	6
Final compliancy, %	85.00	5% less than refs 14, 21
Mortality		
Deaths due to head injuries, %	74.05	Midpoint range, refs 1–4, 14, 20, 44–46
Helmet efficiency, %	70.00	1
Dead on arrival at hospital, %	67.06	1
Average survival time, d	11	1
Cost of intensive care per day, $	1 057	47, 48
Average age at death, y	38.2	24
Life expectancy at 38.2 yrs.	38.3	43
Value of life at 38.2 years, $	181 449	Gross national product method
Value of life per deceased, $	170 519	Human capital method
Hospitalizations		
Helmet efficiency, %	83.20	Midpoint range, refs 12–16, 21, 49, 50
Serious head injuries, %	70.00	15, 26, 44, 46, 51–54
Average length of stay, d	9.7	Neurology department, ref 10
Cost of neurology department per day, $	446	55
Head injuries with other diagnoses, %	12.50	6
Average length of stay, d	4.5	6
Internal/orthopedic department cost per day, $	238	56
Emergency room		
Helmet efficiency, %	83.20	Midpoint range, refs 12–16, 21, 49, 50
Facial trauma alone, %	20.00	17, 57
Mild head trauma, %	24.36	4, 51–53, 58, 59
Severe head trauma, %	8.11	4, 51–53, 58, 59
Average cost per visit, $	117.50	Half of full day's hospitalization
Males, %	87.0	24

(continued)

changes in the discount rate, duration of helmet life, compliancy rate, and helmet effectiveness and cost.

Direct benefit breakeven points (where direct benefits are equal to costs) are met if compliancy falls below 40%, helmets last only 25 months, the helmet effectiveness rate is 37.8%, helmets cost $52.29, or there are more than 4.15 riders per bike. Breakeven points to society are met if compliancy falls below 29.6%, helmets last only 18 months, the helmet effectiveness rate is 17.8%, helmets cost $72.08, or there are more than 5.68 riders per bike.

Changes in the percentage of emergency room visits, unemployment, head injury death, and bike ownership rates, as well as use of the human capital method to value life, had little effect on the benefit to cost ratios.

Discussion

If compulsory bicycle crash helmet legislation were enacted in Israel, considerable reductions in mortality, morbidity, and residual disablement would occur, resulting in net savings of $43.3 million to society over a 5-year period. In almost all of the sensitivity analysis scenarios, both direct and total benefits exceeded program costs.

The benefit–cost ratios are biased downward since our conservative model did not consider reduced pain, worry, grief, work losses for ambulatory visits, or even time off from housework as a result of bicycle injuries. Nor did we consider the intangible benefit of the lessening of anxiety concerning crashes by cyclists or by their friends and relatives. Our calculations excluded revenues from possible fines as a consequence of the legislation, since payments of fines represent simply transfer payments that result in neither a net gain nor a net loss to society.

Another conservative assumption was that helmets would not reduce severe facial injuries, since recent experience revealed a reduction in severe upper facial injuries of approximately 73% as a result of helmet use.[17] Including benefits from decreased upper facial injuries only slightly increased the direct and total benefit–cost ratios to 2.27:1 and 3.13:1, respectively.

Those who object to bicycle helmet legislation argue that legislation infringes on the freedom of the individual. However, there is a legal precedent created by the fact that already-estab-

lished legislation for motorcycle helmets in Israel has resulted in reduced morbidity and mortality.[24] Studies conducted in the United States have shown huge health service cost savings as a result of motorcycle crash helmet legislation.[29–34]

Health education campaigns alone (even with bicycle helmet subsidies) have achieved only low compliancy rates ranging from 7.2% to 32.2%.[14,21,35–39] However, when legislation was added to a health education campaign in Victoria, Australia, compliancy rates rose from 30% to 90% in under a year.[14,21] Similar legislation for children under 16 years of age in Howard County, Maryland, increased compliancy to 47% relative to 19% from a community education program alone in a neighboring county.[40]

The imposition of legislation, backed by the threat of fines, is a powerful and preferred means of raising helmet wearing compliancy. The monetary benefits are sufficiently large to warrant the government ministries and/or the major health insurance funds to consider subsidizing[41] the costs of providing helmets to Israeli bicyclists. □

TABLE 2—Parameters Used in Cost–Benefit Analysis (*Continued*)

	Parameter	Source
Emergency room *(continued)*		
Workdays lost	5.56	23
Average wages lost per cohort member per day, $	21.39	43
Ambulatory visits		
Visits per emergency room survivor	2.00	Panel of doctors
Time of visit, min	15	Panel of doctors
Physician cost per year, $	32 640	60
Physician cost per hour, $	16	60
Short-term disabilities		
Emergency room visits with temporary cognitive disability, %	0.68	2, 61
Cost of rehabilitation care per day, $	7 250	55
Average length of stay, d	89.1	62
Long-term disabilities		
Emergency room visits with permanent cognitive disability, %	0.0028	2, 10, 11
Average age, y	27.0	51
Cost of institutional care per day, $	40.45	Ministry of Labor and Social Welfare
Average length of stay, y	40	51
Lifetime care costs, $	253 000	Discounted
Employable, %	15	Panel of doctors
Working years lost	38	30
Special education		
Extra cost per year, $	7 841	Ref 30, Ministry of Education
Average years needed	5.9	51

TABLE 3—Benefits of Crash Helmet Legislation for Bicyclists for 5 Years[a]

	Before	After	Reduction	Benefits, $	Benefit to Cost Ratio
Deaths	132	75	57	188 773	
Hospitalizations	6 016	3 471	2 544	10 549 317	
Emergency room visits	59 562	46 206	13 355	1 358 673	
Ambulatory care	118 946	92 312	26 634	92 249	
Rehabilitation	1 205	373	832	5 223 610	
Total health service benefits				17 412 622	0.86
Long-term care	167	52	115	25 263 243	
Special education	65.4	20.2	45	1 527 131	
Total direct care benefits				44 202 996	2.19
Mortality benefits				8 939 979	0.44
Work benefits[b]				7 545 779	0.37
Total benefits to society				60 688 755	3.01
Costs				20 143 985	
Total resource savings				43 276 133	

[a]Based on 5.0% discount rate, 85% final compliancy rate, 2% baseline compliancy, 12% unemployment rate, 8.55% bicycle ownership rate, 1.85 riders per bike, helmet effectiveness rates of 83.2% (injuries) and 70% (deaths), 5-year duration of helmet costing $23.40, 70% of deaths and 32.47% of emergency room cases from head injuries, 11.07% of emergency room visits reported, and 0% reduction in facial injuries.
[b]$6 198 569 from reduction in permanent disabilities and $1 347 210 from reduction in emergency room visits.

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