

STUDENT VERSION

*Cases in Population-Oriented
Prevention
(C-POP)*

*Bicycle Helmet Effectiveness
In Preventing Injury and Death*

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Abstract:

This case examines the cost-effectiveness of three interventions to increase utilization of bicycle helmets to avert head injuries in individuals 18 years of age and under in Onondaga County, NY. Students are initially presented with data on head injuries, hospitalization, and death related to bicycle use. They then appraise a published study on the effectiveness of bicycle helmets in averting head injury. Finally, students work in groups to determine the cost-effectiveness of each intervention by calculating implementation costs and the specific number of head injuries averted associated with intervention. The three interventions are legislative, school, and community-based campaigns to increase helmet use. Students are provided with budget estimates and assumptions needed to complete the exercise. Cost-effectiveness analysis, cost-benefit analysis, and related concepts are discussed, including provider versus societal perspectives and importance of sensitivity analysis.

Objectives: At the end of the case, the student will be able to:

- Define “cost-effectiveness” and how it is measured
- Review cost-effectiveness analysis examples from the medical literature
- Interpret trends from data from a State Health Department
- Critically appraise a published clinical study
- Critically appraise strengths and weakness of different study designs
- Calculate and apply cost-effectiveness principles
- Apply economic evaluation concepts

Recommended Reading:

“Study Design,” Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. Edited by A.C. Haddix, S.M. Teutsch, P. A. Shaffer, D.O. Dunet; New York: Oxford University Press, 1996

Anonymous. Injury Control Recommendation: Bicycle Helmets. *MMWR*. 1995; 44 (RR-1): 1-18.

Thompson RS, Rivara FP, Thompson DC. A Case-Control Study of the Effectiveness of Bicycle Safety Helmets. *N Engl J Med*. 1989; 320 (21): 1361-1367.

Section B: Analysis of Available Data- Effectiveness of Bicycle Helmets in Preventing Morbidity and Mortality

As a consultant to the local legislature, you are asked to determine the best means of reducing morbidity and mortality associated with bicycle riding in your county. In order to provide advice regarding this issue, you need to be able to interpret the available data. Local data on morbidity is not available because of the lack of uniform reporting of such injuries. In regard to mortality data, the number of fatalities associated with bicycle use in a community of this size is too small to be useful for analysis. Fortunately, the New York State Department of Health is able to provide you with the information in the following table.

Table 1: Deaths Due to Bicycle Injuries by Age and Sex

Age (in years)	Males: Frequency (rate)*	1996 Population	Females: Frequency (rate)*	1996 Population	Total:(rate)*	1996 Population
0-4	0 (0)	671,564	0 (0)	643,473	0 (0)	1,315,037
5-9	4 (.58)	686,178	0 (0)	652,821	4 (0.30)	1,338,999
10-14	4 (.63)	630,136	0 (0)	600,153	4 (0.33)	1,230,289
15-19	6 (1.01)	596,126	1 (0.18)	570,697	7 (0.60)	1,166,823
20-24	4 (0.65)	611,686	0 (0)	602,435	4 (0.33)	1,214,121
25-44	17 (0.57)	2,973,953	2 (0.07)	3,009,727	19 (0.32)	5,983,680
45-64	9 (0.49)	1,823,532	0 (0)	2,022,921	9 (0.23)	3,846,453
>65	2 (0.21)	943,640	1 (0.07)	1,467,358	3 (0.12)	2,410,998
Total	46 (0.51)	8,936,815	4 (0.04)	9,569,585	50 (0.27)	18,506,998

*Rate: Frequency/ 1996 Estimated Population x 100,000

Source: New York State Department of Health, Bureau of Injury Prevention and Biometrics

Questions:

- 1. Comment on the differences in bicycle injury mortality by age and sex as well as on the interaction between age and sex.**
- 2. What are possible explanations for these differences?**
- 3. How would this information help you formulate prevention strategies for your community?**

The NYSDOH is also able to provide you with the following graphs on overall bicycle-related morbidity and mortality rates, as well as information specific to traumatic brain injury or death due to bicycle use for the period 1991-1996. (Refer to attached Figures 1-4.)

Questions:

4. What are your hypotheses with respect to the trends in rates for death, hospitalization, and traumatic brain injuries associated with bicycle use during these years?

5. What are some of the limitations of the data that have been presented?

Section C: Effectiveness of Bicycle Helmet Use- An Appraisal of Scientific Evidence

In addition to demographic information provided, you need more knowledge about the effectiveness of bicycle helmets before you present your official recommendations to the local health advisory board. You review Thompson, RS et al. “A Case-Control Study of the Effectiveness of Bicycle Safety Helmets” NEJM, May 1989.

Questions:

1. Why did the author choose to do a case-control study to determine cost-effectiveness of helmet use? Could he have done a randomized control study? A prospective cohort study? What are the major limitations of these study designs in this situation?

Section D: Development of Preventive Programs Utilizing a Cost-effectiveness Approach

You now have demographic information about bicycle-related injuries and deaths as well as scientific evidence to support the effectiveness of bicycle helmets in reducing bicycle-related morbidity and mortality. You determine that there are three feasible options for preventive programs aimed to increase helmet use in your county. The options are:

Legislative option: This option involves efforts to educate the public about the passage of a new law that requires helmet use for all individuals 18 years old or younger. It also requires enforcement of this new law.

- Target population (All residents \leq 18 years old): 125,000
- Program costs to be considered:
 - Limited public education (publicity/media) to increase awareness of helmet law;
 - Enforcement of law
 - Provision of helmets: Please note that no helmets are provided under this option. The target population is expected to purchase helmets.

Community option: The local health department is responsible for a comprehensive program to educate the entire community about the risks of bicycle injuries and the benefits of helmet use. The health department will provide helmets at cost to indigent children.

- Target population (All county residents): 450,000
- Program costs to be considered:
 - Health education (publicity/media) of bicycle injuries and helmet use
 - Distribution of helmets at cost to all indigent children
 - Provision of helmets: County provides helmets at cost for indigent children. Based on the most recent census data, the number of indigent children is 20% of all children less than 18 years old ($125,000 \times 20\% = 25,000$).
 - The health department will buy helmets for 25,000 children at \$10 per helmet
 - The health department will sell helmets to parents/guardians of 20,000 children at \$10 per helmet (assuming that not all helmets will be sold)

School option: The school board and the health department are responsible for educating school-aged children about the risks of bicycle injuries and the benefits of helmet use. The health department will provide helmets at cost to indigent children.

- Target population (All school-aged children): 84,000
- Program costs to be considered:
 - Classroom education of helmet use aimed at school-aged children. Educational efforts will also be made to parents of the target population.
 - Distribution of helmets at cost to all indigent children.
 - Provision of helmets: County provides helmets for indigent children at cost. Based on the most recent census data, the number of indigent children is 20% of all school-aged children less than 18 years old ($84,000 \times 20\% = 16,800$).
 - The health department will buy helmets for 16,800 children at \$10 per helmet
 - The health department will sell helmets to the parents/guardians of 13,500 children at \$10 per helmet

Calculating Cost-effectiveness:

You are asked to determine which option is the most cost effective. For each of the options, you need to use the following formula:

$$\text{Cost- Effectiveness} = \frac{\text{Cost of Option}}{\text{Number of Head Injuries Averted}}$$

Both the numerator and the denominator need to be calculated. To determine the total cost of each option, you will need to use your own judgment to determine how much will be spent on personnel costs and how much will be used on the education campaign. For personnel costs, depending on the option, the cost of health educators, of the staff responsible for organizing and distributing helmets, and of officers for enforcement of the law will need to be considered. Guidelines for the estimated costs are provided in the following table.

Table 2: Cost estimates for budget calculation

Program component:	Cost:
Helmets	\$10 cost; \$25 retail
Health education staff	\$40,000/ employee/ year
Helmet program staff	\$30,000/employee/year
Public Information Campaign	
-Develop one television spot	\$10,000
-Pay for one television spot	\$2,000
-Public service television spot	Free- \$250
-Develop and pay for one radio spot	\$350
-Brochures	\$2,500 for 10,000 brochures
Enforcement	\$50,000 per year

Question:

1. What is the total cost of your option?

5. **Do you have any significant concerns about presenting this option as the “best” option when you provide your recommendation to the Health Advisory Board? Consider the perspective of each option when answering this question. Does a health department have a different point of view about the costs they must invest in an intervention than do legislature or society as a whole?**

Section E: Economic Evaluation

When the cost-effectiveness of a program is interpreted, the perspective from which the analysis was performed must be taken into account. In other words, was the analysis done from a broad perspective where all costs and benefits to the population are considered or was it done from a narrow perspective where only costs or benefits to a certain subgroup were addressed? In general, a societal perspective is the broadest perspective. In contrast, an analysis done from the point of view of a hospital or an insurance company provides a much more narrow perspective.

Questions:

1. **From what perspective did you conduct your analysis in Section D? Consider the perspective of each option when answering this question. (For example, does a health department have a different point of view than does the legislature or society as a whole?) How would your results change if you were to conduct your analysis from a societal perspective?**

Thus far in the case, cost-effectiveness has been used to determine the cost per head injury averted. There are different techniques available to conduct an economic analysis, one of which is cost-benefit analysis. Refer to the recommended reading to address the following questions.

2. What is the difference between “Cost-effectiveness Analysis (CEA)” and “Cost-benefit analysis (CBA)”?

3. What are the strengths and weaknesses of each analysis?

4. What questions are best answered by each method?

Finally, because an economic analysis is based on certain sets of assumptions about variables, it should include a “Sensitivity Analysis” in which the assumptions are challenged to see how much they affect the outcome of the analysis. Examples of variables for which sensitivity analysis is helpful include success rate of the intervention, valuation of costs of the intervention, or valuation of the benefits. An example of sensitivity analysis is available in the recommended reading by Gaspoz.

5. In your analysis of the cost-effectiveness of bicycle helmets, what were the most important variables?

6. How would changes in these variables affect the outcome of the analysis?

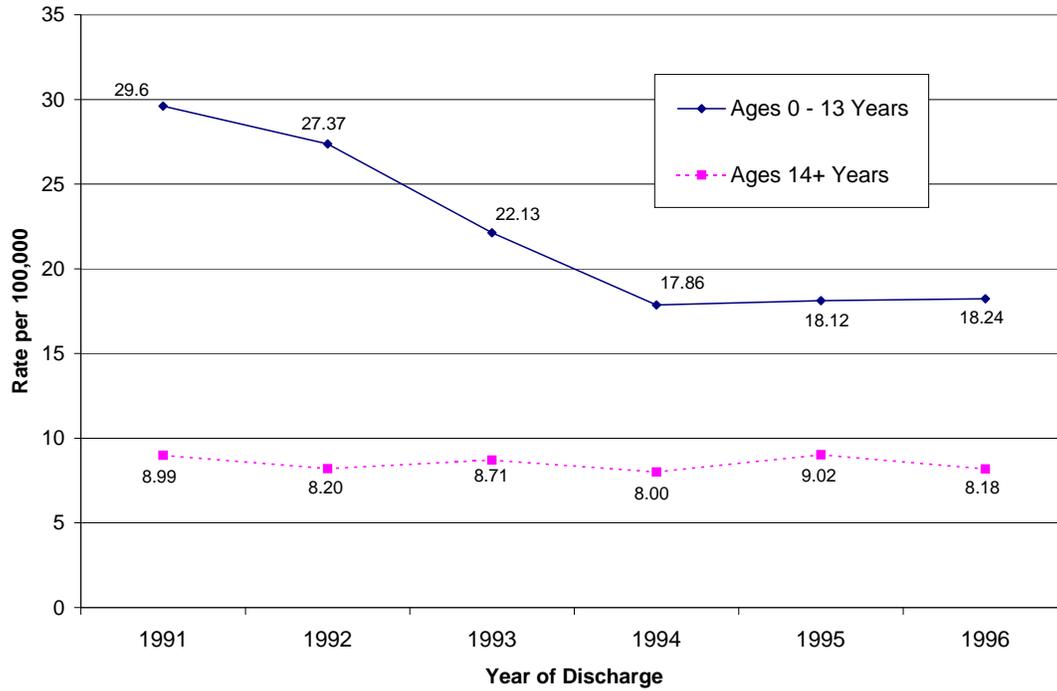
7. Taking perspective, type of economic analysis, and sensitivity analysis into account, which preventive approach do you now think is the most cost effective means to decrease death and injury due to bicycle related accidents in your county?

Figure 1: DEATHS DUE TO BICYCLE-RELATED INJURIES
Rate per 100,000 by Age Group
New York State Residents, 1991 - 1996



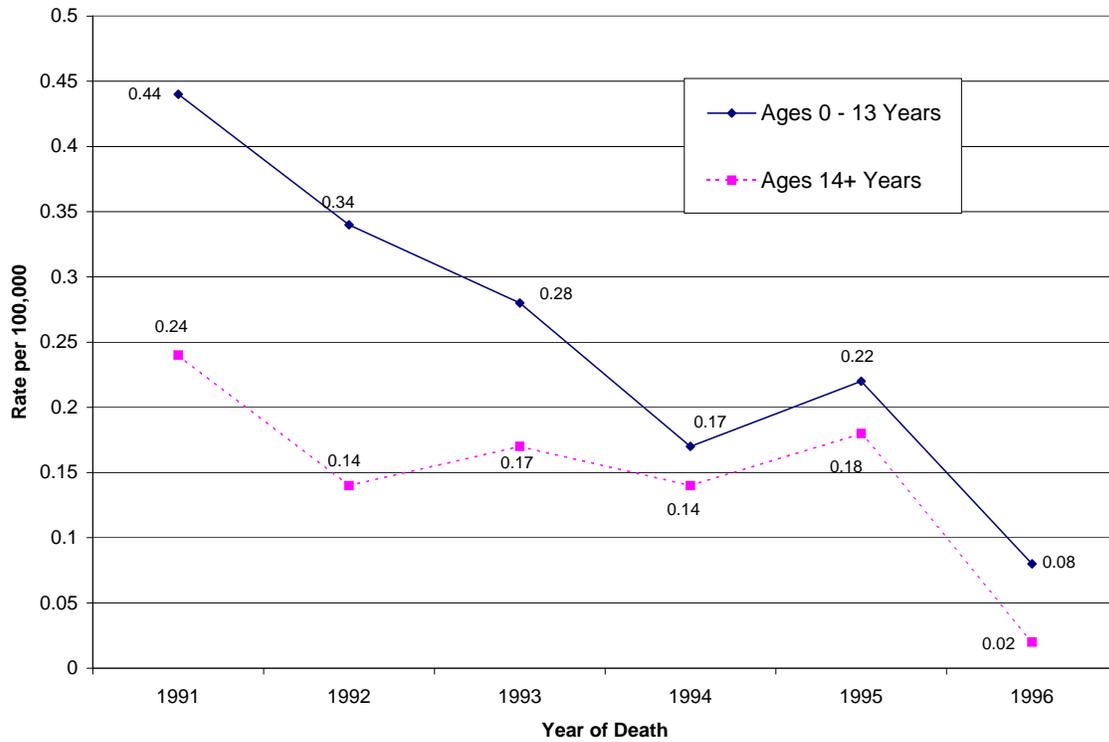
* Source: New York State Department of Health

Figure 2: HOSPITALIZATIONS DUE TO BICYCLE-RELATED INJURIES
Rate per 100,000 by Age Group
New York State Residents, 1991 - 1996



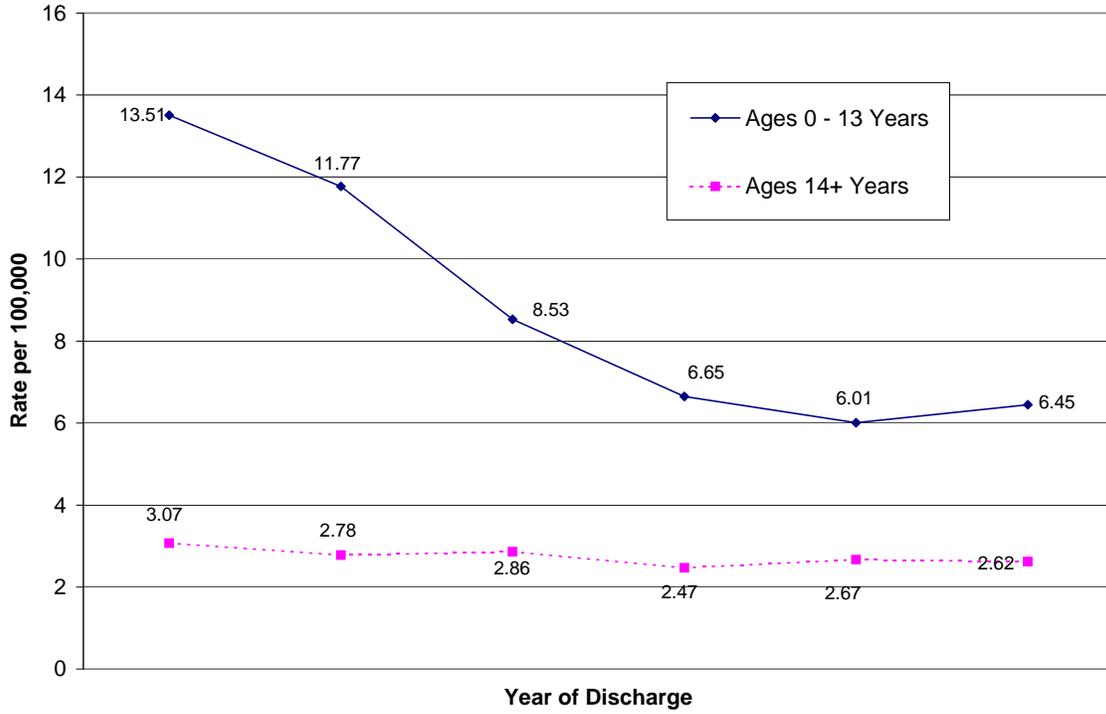
* Source: New York State Department of Health

Figure 3: DEATHS DUE TO BICYCLE-RELATED TRAUMATIC BRAIN INJURIES
Rate per 100,000 by Age Group
New York State Residents, 1991 - 1996



* Source: New York State Department of Health

Figure 4: HOSPITALIZATIONS DUE TO BICYCLE-RELATED TRAUMATIC BRAIN INJURIES
Rate per 100,000 by Age Group
New York State Residents, 1991 - 1996



* Source: New York State Department of Health