The Effects of a 4-Year Program Promoting Bicycle Helmet Use among Children in Quebec

Céline Farley, MSc, Slim Haddad, MD, PhD, and Bruce Brown, MDCM, MPH

ABSTRACT

Objectives. This study assessed the effectiveness of a 4-year program of bicycle helmet promotion that targeted elementary school children in one region of Quebec. The program revolved primarily around persuasive communication and community organization, combining standard educational activities and activities to facilitate helmet acquisition and use.

Methods. Helmet use was compared between more than 8000 young cyclists in municipalities exposed or not exposed to the program. Factors influencing helmet use were controlled through the use of multivariate analyses.

Results. Helmet use increased from 1.3% before program implementation to 33% in 1993. The program was clearly effective in most cycling circumstances and for various groups of children. However, the benefits of the program were unequally distributed; the program was one third as effective in poorer municipalities as in "average–rich" ones.

Conclusions. This community-based program that combined various types of activities appeared to be effective. New intervention models are needed to ensure an equitable distribution of benefits. (*Am J Public Health.* 1995;85:46–51)

Introduction

Bicycle-related injuries are a major public health problem in the province of Quebec in Canada, as they are throughout North America. About 10% of all deaths (all causes combined) among 5- to 14-year-old children in Quebec result from bicycle crashes.[1] Head injuries are frequent, being present in 60% to 80% of fatalities.[2–5]

Helmet use contributes to reducing the frequency and severity of head injuries; studies report a reduction in the risk of head injuries in the range of 45% to 85%.[6–8] Several evaluations of bicycle safety helmet promotion programs have been published[9–19]; program effectiveness was assessed with indicators including helmet purchase and ownership,[11–13,15] evolution of helmet use,[10,13,17,19] and evolution of the prevalence of bicycle-related head injuries.[9,16]

Evaluations of programs based on multiple-intervention strategies involving community and school-based activities usually report an increase in helmet use over time.[10,13,16–18] It should be noted, however, that the relationship between improved helmet use and these programs is not always evident; either there is no control group,[14,16,17] thus overlooking the possibility of a secular trend, or, more frequently, the analyses do not take into account the different exogenous variables likely to influence helmet use. Significant associations between helmet use, age, sex, family income, observation site, day of week, and the presence or absence of other cyclists wearing helmets have been reported.[10,13,16]

Some evaluations have been based on repeated measures.[10,16] Nevertheless, there is little information about the evolution of helmet use in relation to the length of time the programs have been in operation. The studies we consulted also lacked details concerning the effects of the programs on different categories of children. Does the effectiveness of a program differ depending on the age and sex of the children? Are interventions promoting helmet use less effective among children in lower income areas, as suggested by one Canadian study?[13] Is the effectiveness of a program independent of the circumstances in which the cyclists are riding, or are there greater effects for riders on bicycle paths, on their way to school, or simply out for a ride in their neighborhood? From a public health standpoint, this information is essential to determine the specific efforts needed to reach those groups that are more resistant to wearing helmets so that programs can be adequately adjusted in terms of strategies and activities and program objectives can be reached most effectively and rapidly.

This article reports the results of an evaluation of the effectiveness of a 4-year program promoting bicycle helmet use among children in the Montérégie (one of 16 administrative regions in Quebec, located on the South Shore of Montreal, with a population of 1.2 million living in more than 230 municipalities).

Céline Farley and Bruce Brown are with the Charles LeMoyne Public Health Unit, South Shore Regional Board of Health and Social Services, Montreal, Quebec, Canada. Slim Haddad is with the Groupe de Recherche Interdisciplinaire en Santé and the International Health Unit, University of Montreal.

Requests for reprints should be sent to Slim Haddad, MD, PhD, Groupe de Recherche Interdisciplinaire en Santé, Université de Montréal, Pavillon Marguerite d'Youville, 2375 chemin de la côte Ste-Catherine, C.P. 6128, Succ. A, Montreal, Quebec, Canada H3C 3J7.

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Bicycle Helmet Promotion Program in the Montérégie, 1990 to 1993

The program targeted elementary school children 5 to 12 years of age attending French and English public schools in the Montérégie (approximately 380 schools and 100 000 children). At the time of the preliminary study in 1988, only 1.3% of children in this age group were wearing a bicycle helmet. The program objective was to bring this level up to 20% by 1993.

The program design was based on the PRECEDE[20] framework and on Rogers' diffusion of innovations theory.[21] A preliminary study identified those factors likely to influence the intention of young cyclists to use helmets and the content of the messages to be conveyed.[22]

Intervention strategies focused on persuasive communication and community organization. The program began in 1990, and the activities took place every year, from April to August, through 1993. Standard educational activities (posters, pamphlets, association games, role playing) to encourage changes in attitudes, beliefs, and values with regard to helmets were carried out mainly in schools in May and June. Community-based activities focusing on facilitating helmet acquisition (increased product availability, discount coupons for $5 and $10, group purchases, offering of helmets as prizes) and reinforcing helmet use (awards, guidelines and regulations requiring helmet use) were conducted from April to August.

An organizing committee handled program coordination, and the activities were conducted by a variety of people and organizations working to promote bicycle safety: teachers, police officers, social clubs, sporting goods retailers, municipal recreation departments, and organizers of sporting events. More than 200 schools and 250 agencies participated in the program each year. Between 1990 and 1993, 12 214 posters, 319 944 pamphlets, 4965 educational guides, and 72 672 coupons were distributed throughout the region. More than 4600 bicycle helmets were given out free to children.

Methods

The evaluation was based on a quasi-experimental design with repeated measures and nonrandom control groups. Observation studies were conducted in 1991, 1992, and 1993 (the second, third, and fourth years of the program, respectively) to compare helmet use between the two groups of children. The study group was involved in the intervention and observation phases in all 3 years, while the control group was involved only in the observation phase in each of the study years. The study group included children 5 to 12 years of age residing in 25 municipalities in the Montérégie region, stratified by subregion from among the 230 municipalities included in the program. The control group included children of the same ages residing in municipalities in another region about 40 km north of Montreal that did not have a similar program. These municipalities were chosen for their similarities to those in the study group in terms of distance from Montreal, population size, and proportion of the population below the low-income threshold, as defined by Statistics Canada.[23] Observation sites and methodology were the same each year and included routes on which children rode to school (in June and September), use of bicycle paths and riding in residential and commercial streets (from June to September).

An observation grid was developed, validated, and pretested for the purpose of data collection. Observers were trained before data collection (interrater reliability was not assessed). Observers were instructed to stay at a single site for no more than 30 minutes and in one observation area for no more than 90 minutes. Children's ages were estimated by observers. For analysis, children were divided into two categories according to their probable age (5- to 8-year-olds and 9- to 12-year-olds). The proportion of the population below the low-income threshold, as defined by Statistics Canada,[23] was used as a proxy for the variable of socioeconomic level. Municipalities were divided into two categories, "average–rich" and "poor," depending on whether this proportion was greater than or less than 20%; all children from any given municipality were assigned to one category.

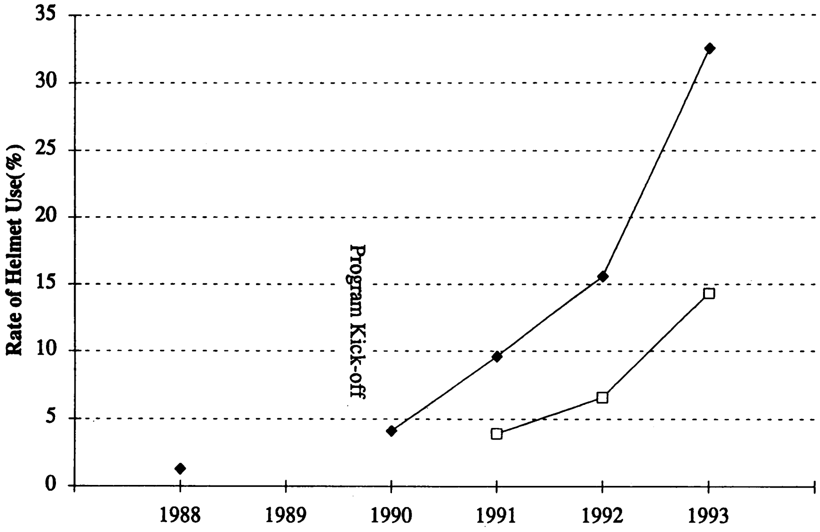
The data were analyzed in two stages. We first examined the evolution of helmet use in the Montérégie and in the control municipalities for the entire study period. The effect of the program was evaluated by comparing helmet use between the groups that were exposed to the program and those that were not. This analysis was based on multiple logistic regressions that allowed—through a process similar to that of Mantel–Haenszel—adjustment of the relative risks in considering the effects of modifying factors. Interaction terms permitted these models to assess whether or not the effects of the program differed according to year, characteristics of the children observed, or circumstances of the observation. (An appendix of the model for calculating relative risk is available from the authors.)

In order to increase the precision of estimates and to document program effectiveness across years, we analyzed program data that included several years of observation.[10] In principle, this procedure requires independent samples, which cannot be guaranteed in observational studies. In this study, the risk of recounting the same child in different years was relatively small; approximately 2% of the total study population was observed each year, and the population was changing (each year, there is roughly a 16% turnover of children [5-year-olds entering and 12-year-olds leaving]). We chose to include observations from the 3 years in a single sample, introducing a "year" variable in the analysis; in interpreting these results, we were particularly conservative, using a significance level of .001 and focusing on results with particularly high (or low) relative risks.

Helmet use was the dependent variable of the model, and group (study or control) was the independent variable being studied. The other independent variables were age, sex, observation site, municipality, time of observation, period of week, and year of observation. To distinguish the effects of the program according to the characteristics of the children, observation circumstances, and length of time the program had been operating, we included seven interaction terms (between the group in question and each of the seven other independent variables). The parameters of the model were estimated with Egret software. The maximum likelihood test was used in evaluating the contribution of each of the variables. The software allowed us to split the ordinal variables, such as the observation site and year, into dichotomous variables (one ordinal variable with m values results in $m - 1$ dichotomous variables).

Results

Of the 8112 children observed, 6087 were in exposed municipalities. The majority were boys (5106), and two thirds fell into the 9- to 12-year age bracket (5583).



Note. □ = control group; ◆ = study group. Baseline observations for control municipalities were not available.

FIGURE 1—The evolution of helmet use among children in the Montérégie and the control municipalities.

TABLE 1—Rates of Helmet Use among Children in Municipalities Exposed (Study Group) and Not Exposed (Control Group) to a Program of Bicycle Helmet Promotion: 1991 and 1993

	1991, %		1993, %	
	Study Group (n = 1566)	Control Group (n = 518)	Study Group (n = 2736)	Control Group (n = 1096)
Sex				
Male	8.2	3.7	28.5	12.5
Female	11.9	4.3	38.6	17.8
Age group, y				
9–12	6.6	1.5	24.3	12.2
5–8	18.9	7.7	47.7	20.9
Observation site				
Local street	5.0	3.8	33.0	11.5
Path/lane	28.7	8.3	42.3	30.2
School route	9.3	2.6	26.5	14.7
Period of week				
Weekday	8.2	4.3	33.0	13.6
Weekend	24.0	2.5	30.0	18.2
Time of day				
Morning	4.8	4.1	32.3	17.2
Afternoon	13.3	3.8	33.3	13.8
Evening	15.4		28.4	11.4
Socioeconomic level of municipality				
Poor	3.1	4.1	25.8	15.2
Average–rich	10.9	2.8	33.7	11.8
All children	9.6	3.9	32.5	14.3

One third of the observations were conducted in low-income municipalities (2630). Half of the children were observed on local streets (3999), 40% were observed on school routes (3208) and 11% were observed on bicycle paths or lanes (905).

Helmet use grew steadily and substantially in the Montérégie (Figure 1). Only 1.3% of children wore helmets before implementation of the program. This figure rose to 1 in 10 after the second year of the program and more than 1 in 3 after the fourth year. The helmet use rate also increased in the control group; it tripled between 1991 and 1993 (1988 baseline data for the control group were not available).

Helmet use rose from year to year regardless of the municipality in question, the circumstance of bicycle use, or the age and sex of the children (Table 1). Helmets were worn more by girls, children in the younger age group, and those riding on bicycle paths. In the Montérégie, helmets were worn more in the average–rich municipalities than in the poor ones. Opposite results were observed in the control group.

Preliminary regressions were carried out to select the variables for the final model. The time of observation and period of week variables and their interaction terms made no significant contribution and were omitted in subsequent analyses. The coefficients assigned to the following interaction terms were also not significant: Study Population × Sex ($P = .4$), Study Group × Age ($P = .64$), and Study Group × Years ($P = .53$ and $P = .24$). This suggested that the effects of the program did not differ between girls and boys, age groups, or different years. These terms were also eliminated. The results of the final model are shown in Table 2.

With regard to our thresholds ($P < .001$), municipality status was not significantly associated with helmet use. However, interaction terms were significant, and we maintained this variable in the model. Helmet use was significantly and positively associated with girls, the younger age group, bike paths, and school roads (vs local streets). The program was effective, since being part of the study population was significantly associated with helmet use ($P < .001$). Since the interaction terms were significant, the effectiveness of the program had to be distinguished according to the type of municipality and the observation site considered. Table 3 gives adjusted relative risks in each riding circumstance for poor and average–rich municipalities (see the Appendix for the process allowing for calculation of relative risks in the presence of an interaction).

Table 3 demonstrates that children in poor communities riding on local streets in the exposed population were

1.76 times more likely to be wearing bicycle helmets than children riding on local streets in poor communities in the control population. Regardless of the circumstances in which the children were riding, the program was 3 times more effective in the average–rich municipalities than in the poor ones. The program seemed to be effective in all areas of average–rich municipalities; in poor ones, however, it was effective only on local streets. Regardless of municipality status, it seemed to be more effective on local streets than on bicycle paths and school routes.

TABLE 2—Logistic Regression Analysis of Factors Associated with the Use of Helmets by 5- to 12-Year-Old Children in Two Regions of Quebec: 1991 through 1993

Variable	Coefficient	SE	Odds Ratio (.999 Confidence Interval)
Constant	−3.859	0.14	
Exposure to program (vs non-exposure to program)	0.5784	0.147	1.78 (1.10, 2.89)
Girls (vs boys)	0.4287	0.061	1.54 (1.26, 1.88)
5–8-year age group (vs 9–12-year age group)	0.9658	0.0621	2.63 (2.14, 3.22)
Path or bicycle lane (vs local street)	1.252	0.214	3.50 (1.73, 7.06)
School route (vs local street)	0.4949	0.181	1.64 (0.91, 2.97)
Municipality = Average–rich municipality (vs poor municipality)	−0.6098	0.194	0.54 (0.29, 1.03)
1992 (vs 1991)	0.5341	0.106	1.71 (1.20, 2.42)
1993 (vs 1991)	1.398	0.0922	4.05 (2.99, 5.48)
Study Population × Path or Bicycle Lane (vs control and/or local street or school route)	−0.5176	0.235	0.60 (0.28, 1.29)
Study Population × School Route (vs control and/or local street or bicycle path)	−0.66	0.196	0.52 (0.27, 0.98)
Study Population × Average–Rich Municipality (vs control and/or poor municipality)	1.221	0.217	3.39 (1.66, 6.91)

Note. n = 8112; deviance (df = 8100) = 6815.60; maximum likelihood ratio (df = 12) = 4430.715 (P < .01).

TABLE 3—Variations in Program Effectiveness, by Type of Municipality and Cycling Circumstances

	Relative Risk (.999 Confidence Interval)		
Municipality	Local Street	Bicycle Path	School Road
Poor	1.76 (1.10, 2.78)	1.06 (0.66, 1.57)	0.92 (0.57, 1.48)
Average–rich	5.72 (3.53, 9.30)	3.28 (2.13, 4.87)	3.01 (1.83, 4.95)

Note. Relative risks were adjusted for gender, age, year of observation, cycling circumstances, and type of municipality.

Discussion

As noted in other studies, helmet use is significantly associated with age, sex, and cycling circumstances.[10,16,17] The fact that helmets are worn less on local streets than on bicycle paths may be due to different factors. First, parents may perceive bicycle rides around the family home as safer and therefore requiring helmet use less than long rides on bicycle paths (a recent Quebec survey[24] found that lack of helmet use was associated with the use of bicycles to ride short distances). This is similar to behaviors associated with the use of safety belts; because people do not perceive the risk of accidents when driving short distances, they tend not to use safety belts and child restraint systems on short car rides.[25,26] Second, because there are no places to store helmets in public areas, children may wear helmets less when they are riding around their neighborhoods. Third, the fact that helmets are worn less on school routes may be explained by peer pressure. Previous studies suggest that helmet use is associated with the presence of helmeted companions.[10]

The secular trend of increasing helmet use in both the study and control populations reflects the progressive diffusion of the innovation (bicycle helmet use). A nationwide bicycle helmet promotion campaign sponsored by the Canadian Medical Association, as well as other programs developed in Quebec and elsewhere in Canada, was introduced during the course of our program. This trend underlines the need for a control group to evaluate the effects of the program.

Program effectiveness was assessed with very conservative thresholds to minimize bias related to possible nonindependence of samples. The process used to measure the effectiveness of the program involved two fundamental advantages. First, it allowed measurement of the effects of the program while taking into account factors likely to influence helmet use. Second, the analysis of the interaction terms (not conducted in the previous studies to which we had access) allowed assessment of effectiveness from year to year, among different categories of children, and in different cycling circumstances.

The analysis of the evolution of helmet use rates and relative risks associated with exposure to the program suggests that (1) the program was effective in most circumstances, (2) it was just as effective among younger as among older children and was effective among girls as well as boys, and (3) its effectiveness was similar in 1991, 1992, and 1993.

The fact that program effectiveness did not vary according to the sex and age of the children can be regarded as a success. As far as the circumstances of bicycle use are concerned, we believe that the fact that the program was effective only on local streets cannot be considered as a negative result. One of the unique elements of this program was that it placed a priority on reducing head injuries by intervening in areas where the frequency of bicycle accidents was highest (i.e., on residential streets and in areas close to the children's homes[27]); the program focused on activities that promoted helmet use (incentives to wear helmets in activities run by recreation departments all summer, rewards from police officers for children wearing helmets, organization of bicycle events or bicycle safety days) in local neighborhoods during the 2 months of summer when the children were out of school.

Taking into account the limits set for statistical acceptance, the association between helmet use and municipality was not significant ($P = .02$) (even though the interaction term was significant, $P < .001$). This can be explained first by the fact that, surprisingly, children residing in average or rich municipalities in the control region wore helmets less than their counterparts in poor municipalities. This could be due in part to contamination of the control group in 1993, when 21% of this group, including the largest poor community, was exposed to an independent bicycle helmet promotion campaign. The nonsignificant association between helmet use and municipality can also be explained by a lack of power of the test. In fact, tests with the municipality variable were very conservative because of the use of an indirect measure of socioeconomic status—a proxy—whose reliability was necessarily limited.[28] Thus, we presumably underestimated first, the real association between helmet use and socioeconomic status and, second, differences in program effectiveness between poor municipalities and average–rich ones.

It is unfortunate that the program was less effective in the poorer municipalities where the children were most exposed to traffic accidents.[29] This was true despite the implementation of various activities designed to promote helmet acquisition, including $5 and $10 discount coupons, group purchase rates, and free helmets. Similar results were reported by Parkin et al. in Ontario.[13] Comments made by teachers and community workers in these low-income areas confirmed this gap between municipalities and suggest that helmet cost may be a barrier to acquisition. Thus, even if discount coupons can "play a central role"[16] in program effectiveness, they seem to be insufficient in the specific context of this study, where 21% of children were members of poor families and 11% came from extremely poor families.[30] For these families, the purchase of a helmet, even at a unit price of $14, is an investment that may be out of range for their budgets.

As far as we know, the significant increase observed in helmet use—from 1.3% in 1988 to 33% in 1993—constitutes a unique result, given that the initial rate of helmet use was exceptionally low. Like Seattle's study,[16] this study suggests that a program revolving primarily around persuasive communication and community organization that combines traditional educational activities with activities reinforcing helmet use and improving helmet accessibility is capable of substantially increasing bicycle safety helmet use. In addition, this approach seems to be cost-effective since annual costs of the program per targeted child were estimated at $0.70. Our study does, however, raise questions concerning the equitable nature of this program and of health promotion interventions in general. New intervention models need to be developed to further assess these issues and to ensure an equitable distribution of the benefits of health promotion actions. □

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Congress of the International Association of Health Policy to Be Held in Montréal

The Université de Montréal will be hosting the 9th Congress of the International Association of Health Policy (IAHP) from Thursday, June 13, to Sunday, June 16, 1996, in Montréal, Canada.

The conference theme will be "Beyond Medical Care: Policies for Health." Topics will include the social determinants of health, the market and the state, the central and the local, the role of civil society, and international aid.

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