The Promotion of Safe Behaviours at the Community Level

Evaluation of a Bicycle Helmet-Wearing Campaign among 5- to 12-Year-Old Children

Céline Farley
Stockholm 2003
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Abstract

Bicycle-related injuries are among the most important public health problems in childhood. In the Montérégie Region (Québec, Canada), at the beginning of the 1990s, a 4-year community-based program aimed at promoting voluntary bicycle helmet wearing among children aged 5-12 was implemented. The program’s target was to increase the rate of helmet use from 1.3% before the program (1989) to 20% in 1993 and, thereby, to reduce the rate of bicycle-related head injuries leading to hospitalisation. The aim of the thesis is to assess the impact and outcome of the Montérégie program, considering children’s age and sex and socio-economic status. Four studies form the thesis, each of which includes a comparison community and repeated measures in both the intervention and reference community. The first two studies focus on behavioural changes over time. Study 1 was questionnaire-based and addressed self-reported measures including e.g., children’s intention to wear a helmet and to own a helmet. Study 2 was observation-based and essentially concerned with behavioural changes de facto, both in general and according to various cycling environments (i.e., sites and living areas).

The results show an increasing adoption of the target behaviour over time. The program was effective in increasing children’s motivation both to use and to own a bicycle helmet. After the program had been operating for four years, 56% of the children in the target community, compared to 36% in comparison community reported owning a helmet. The program had an accelerating effect on ownership and it was the main predictor of high intention to use a bicycle helmet. Furthermore, helmet use when cycling grew steadily and substantially over time in the target community, from a rate of 1.3% before the program implementation to 32.5% after the fourth year of the program, compared to 14% in comparison community. Helmets were worn less among boys, older children, among children observed both on school roads, and in poor municipalities. The program proved to be only one-in-three times as effective among children observed in poor municipalities as is richer ones. Study 3 and 4 dealt with changes in head-injury risks over time, considering in turn age and sex of the child (study 3) and living area socio-economic status (study 4). Data on children who were hospitalised because of bicycle-related injuries for the years 1988-1996 were obtained from the Provincial Government inpatient register that offers full coverage of hospitalisations in Quebec. A reduction of the rate of hospitalisation for bicycle-related head injuries over time was observed among boys and girls, younger and older children and also among children from both poor and average-rich municipalities. The program’s positive impact on head-injury risk reduction was maintained during the three-year period following the completion of the program. In spite of the lower penetration of the program among higher risk groups in terms of helmet wearing (i.e., boys, children from poor municipalities), all groups obtained a reduction of injury-risk levels.

As a whole, the results reveal favourable results in terms of increased bicycle-helmet wearing and decreased head-injury morbidity. It is very likely that the program in itself is responsible for a large share of those favourable results. Among other assets, it was based on multiple strategies consistent with underlying theory of behavioural change and planning framework and it included a wide variety of activities undertaken yearly and targeted towards determinant stakeholders. Also, the process was followed up very closely.

In general terms, the result support the idea that population-based educational programs have the potential to impact on bicycle-related head injury reduction for all. They can benefit children from less accessible and most at risk groups, without stigmatising them unduly or threatening their autonomy.

Key words: Safe behaviour, community-based program evaluation, bicycle helmet, voluntary behavioural change, socio-economic context.
1 BACKGROUND

1.1 Injuries and bicycling

Bicycling is a popular recreational activity and a sound alternative mode of transportation that can reduce traffic congestion and air pollution and enhance physical fitness. Bicycles can also offer a degree of autonomy to young people without access to cars. As in several European countries, bicycle use has seen a significant increase in North America. In the United States, there are 67 million bicyclists who ride approximately 15 billion hours per year (Rivara, 1998) and a national survey estimated that 72.7% of children 5-14 years old ride bicycle, that is 27.7 million child bicyclists (Sacks, 1996). Similar trends have been observed in Canada. Bicycling is especially popular among young Canadians. The results of a national survey conducted in 1995 (Millar, 2000) showed that approximately 80% of young Canadians, aged 12 or under used a bicycle. Earlier in Québec, the majority of children aged 8 to 12 years old, questioned during a survey reported that they bicycled twice a week during the summer season (Lesage, 1989). As early as 1987, over 25% of the québécois population enjoyed regular cycling during the warmer months (April to October) and the number of bicycles, including children’s models was estimated at close to 3.5 million units in 1992 (MTQ and SAAQ, 1995), for a population of 7 million inhabitants.

Although bicycling offers numerous benefits, it does have a negative component as well, that of death and injury related to bicycle use. The public health significance of injuries caused by bicycle use, especially head injuries, has been measured in many parts of the world e.g., in Canada (MacWilliam, 1987; Cushman, 1990; Schwartz, 1996; Linn, 1998; Mo, 2002; Ong, 2003), in Québec (Brown B, 1989), and elsewhere (Gallagher, 1984; Kraus, 1987; Rivara, 1997; SIKA, 1999; Ekman, 2001). Studies have highlighted that bicycling carries substantially greater risks for children (Brown, 1989; Coppens, 1995).

In Canada, the annual mortality rate in 1992 for bicycle-related injuries in children was 0.6 per 100,000 children, with a concomitant annual hospitalization rate of 51 per 100,000 (Beaulne, 1997). From 1994-1997, almost 10,000 Canadian children were hospitalised because of bicycle-related injuries; 35% of these admissions were because of injuries to the head.

Over the years 1980-2000, about 736 cyclists died in the province of Québec, i.e. around 37 each year, and at least 10,600 bicyclists were hospitalized during the past decade (1990-2000) (Choinière, 1993; Masson, 1998; Hamel, 2001). For the period 1994-1995, children aged 5 to 14 accounted for 38% of the deaths (average
annual rate of death of 1.5/100,000) and 44% of the hospitalizations (average annual rate of hospitalization of 59.9/100,000) related to bicycle accidents (Hamel, 2001). Head injuries cause respectively 55% of deaths and 35% of hospital admissions for bicycle trauma (1993-1995) (Masson, 1998). Minor injuries associated with bicycle use are more frequent than hospitalizations (SAAQ, 1998; Beaulne, 1997), but are not always inconsequential. In fact, a survey conducted in Québec estimated the number of bicyclists who had suffered an injury requiring a medical consult between October 1992 and September 1993 to be approximately 14,000 (Impact recherche, 1993).

The social costs associated with head injuries resulting from bicycle accidents are high and add to the extent of the problem. Dannenberg & Vernick (1993a) estimated that each severe bicycle-related head injury could result in extensive medical and rehabilitative care that can cost over US$250,000. In Québec the scope of the direct and indirect costs associated with injuries seen in cyclists is not well known. Nevertheless, in 1997, claims paid to cyclists involved in a collision with a motor vehicle by the Québec Automobile Insurance Board were estimated to be CDN$33.9 million, $9.2 million of which (27%) were for a head injury (MTQ-SAAQ, 1999). It is also estimated that if 85% of all children riding a bicycle in the US wore helmets for one year, the medical cost savings would be some $109 to 142 million (Coppens, 1995).

1.2 Risk factors

The circumstances surrounding fatal injuries in young cyclists are clearly different than those that are less serious. The majority of the deaths are the result of a collision with a motor vehicle and they occur most frequently among male cyclists. Non-fatal injuries requiring hospitalization occur in the majority of cases outside of public roadways, that is with no link to a motor vehicle (Masson, 1998; Hamel, 2001).

Generally speaking the risk factors associated with bicycle accidents or injuries can be divided into three categories: environmental factors (physical and social), factors linked to the individual (cyclists) or factors linked to the agent, i.e. the bicycle itself.

Environment: It appears that the geometric design of bicycle paths, including the situational environment (speed, traffic flow, etc) increases the probability of accidents among cyclists. In fact, a report published for the British Medical Association shows that bicycle accident rates per kilometre travelled are three to four times higher on bicycle paths than on roads where the roadway is shared by cyclists and car drivers (Hillman, 1992). Moreover, it has been observed that
separating bicycles from the roadway by encouraging bicycling on bicycle paths or sidewalks can increase risks to cyclists at the intersection of bike paths and sidewalks with roads (Wachtel, 1994a; 1994b). The design of intersections has also been identified as one of the most problematic elements for cyclist safety, increasing the probability of conflict between cyclists and car drivers (Leden, 1992; Gärner, 1994). Other factors linked to the road safety code such as exceeding the maximum speed posted and the consumption of alcohol in excess of the amount allowed for drivers of vehicles can increase the probability of accidents among cyclists (Spence, 1993; Rowe, 1995).

**Individual:** The age and sex of children are factors that influence the probability that bicycle injuries will occur. As mentioned above, boys are over-represented in terms of morbidity and mortality linked to bicycle accidents. Differences in cycling habits and cycling behaviours between sexes can explain this fact. Also, child development makes younger children more prone to fall off a bicycle and lose control of a bicycle or makes them more prone to adopt unsafe behaviour (i.e. running a red light or stop sign, entering the roadway between two cars without first looking) (Brown, 1997; Linn, 1998).

**Bicycle:** Factors linked to the bicycle itself rarely contribute to deaths of cyclists and are a triggering factor for the accident in approximately 2.4% of cases of injury in children (Brown, 1997). Defects in the bicycle most often have to do with brake failure, loss of wheels and problems with the chains.

### 1.3 Measures for prevention of bicycle injuries

In the injury-prevention and safety-promotion arena, the literature highlights several measures against bicycle injuries, which concern risk factors (environment, agent and individual). Passive measures attempt to control the conditions and try to reduce the hazards to which bicyclists are exposed. They are often regarded as abatement strategies capable of leading to considerable risk reduction without putting excessive demands on individual compliance and conscious participation. Road design (lane widths, roadway surfaces, and traffic signs) and cycling accommodation (cycle lane, separate lying cycle track, adjoining cycle track, cycle track) are considered to be effective manners of preventing the occurrence of injury (crashes). However, there has not been much research on the effectiveness of this kind of measures and side effects can be expected (Wachtel, 1994a; 1994b; Brown, 1998).

For their part, active measures are more demanding – they can be imposed or encouraged, and their adoption may require a considerable amount of community work. This kind of measure requires influencing behaviour through increased
knowledge, skill, and awareness. Bicycle-helmet wearing can be regarded as an active, individual form of protection and it has a strong potential for reducing the risk of bicycle-related head injuries (Thompson, 1989; 1990; 1996a; 1996b; McDermott, 1993; Maimaris, 1994; Thomas, 1994; Henderson, 1995; Rivara, 1998). Although some authors have argued against the efficacy of helmets (McCarth, 1992; Hillman, 1993), published reviews (Henderson, 1995; Coffman, 2003; Thompson, 2003) and meta-analysis (Attewell, 2001) demonstrate that helmets protect cyclists from head injuries and may reduce head injury risks by up to 88%, and facial injury by 65%.

Enforcement and education are two strategies used in the attempt to increase and sustain bicycle helmet use. Enforcement is implemented in the form of helmet legislation – and usually follows an educational campaign, as was the case for instance in New Zealand and Australia. Many governments in the world have adopted mandatory bicycle helmet wearing or are in the process of doing so. The state of Victoria in Australia was the first place in the world where such a law was adopted in 1990 (Vulcan, 1992). Other countries have followed suit including the U.S. (especially for youngsters), New Zealand (in 1994; for all cyclists) (Scuffham, 2000) and Canada. By 2001 in the U.S., 17 states, the District of Columbia, and numerous local governments had passed bicycle helmet legislation for children (National Safe Kid, 2002). At the present time, one in two Canadian provinces has a law prescribing mandatory bicycle-helmet wearing (see Table 1).

**Table 1. Canadian provinces with bicycle helmet legislation (in 2003)**

<table>
<thead>
<tr>
<th>Province</th>
<th>Date of Adoption of Legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario (for children &lt; 18)</td>
<td>October, 1995</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>December, 1995</td>
</tr>
<tr>
<td>British Colombia</td>
<td>September, 1996</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>July, 1997</td>
</tr>
<tr>
<td>Alberta (for children &lt; 18)</td>
<td>May, 2002</td>
</tr>
</tbody>
</table>

The point has been made that legislation is the most cost effective method to increase bicycle helmet use (Hatziandreu, 1995). A recent Canadian study of the impact of mandatory bicycle-helmet wearing shows that the reduction in the rate of bicycle-related head injuries over a 4-year period was 45% in provinces with legislation as compared to 27% in provinces without such legislation (Macpherson, 2002).

Otherwise, educational campaigns on bicycle helmet effectiveness in preventing head injury is a popular type of intervention, that can be community-based, school-
based, physician-based, or some combination. There are also a number of educational programs with documented success in increasing the voluntary use of bicycle helmets – Canada (Cushman, 1990; 1991; Ekman, 1991; Morris, 1991; Parkin, 1993; 1995; Rourke, 1994), the USA (DiGuiseppi, 1989; Coté, 1992; Dannenberg, 1993c; Liller, 1995), Australia (Wood, 1988), New Zealand (Moore, 1990) and Sweden (Ekman, 1997).

1.4 Helmet use and associated psychosocial factors

Without promotion, the prevalence of bicycle helmet use remains low despite research indicating the high level of risk of head injury when bicycling without a helmet and the significant protection offered by bicycle helmets. Observational studies conducted in the early 1990s reported bicycle helmet use to be between 0% and 13% in areas that have not received interventions designed to increase bicycle helmet use (Wood, 1988; DiGuiseppi, 1989; Brown, 1989; Bergman, 1990; Morris, 1991, 1994; Towner, 1992; Otis, 1992; Parkin, 1993; Dannenberg, 1993b; Rivara, 1994; Rouke, 1994; Liller, 1995).

Studies have identified factors associated with the use or non-use of helmets by cyclists. Research-documented barriers to helmet use have remained relatively consistent over time: lack of knowledge about helmets (DiGuiseppi, 1990; Ashbaugh, 1995; Miller, 1996), discomfort caused by helmets (Joshie, 1994; Seijts, 1995; Finch, 1996; Miller, 1996; Loubeau, 2000; Finnoff, 2001; Westerling, 2001), normative aspects, such as perceived disapproval of peers and fear of being teased and of looking foolish (Elliot, 1986; Howland, 1989; Otis, 1992; Seijts, 1995; Finch, 1996; Westerling, 2001), helmet cost (DiGuiseppi, 1990; Harlos, 1999), poor role modelling by peers and parents or other adults (DiGuiseppi, 1990; Finnoff, 2001; Twomey, 2001). From another point of view, several factors are positively associated with the wearing of helmets by children, they are legislation mandating helmet use and enforcement of legislation (Bolen, 1999; Gilchrist, 2000), higher education or income (Parkins, 1993; Miller, 1996; Harlos, 1999), younger age, female children, parent pressure (Finch, 1996; Miller, 1996) and presence of other cyclists wearing helmets (DiGuiseppi, 1990; Rivara, 1994).

1.5 Evaluating community-based bicycle helmet programs

Over the last 40 years, many authors have suggested definitions for evaluation. Several textbooks, such as those of Suchman (1967), Wholey et al. (1994) and Rootman et al. (2001) have proposed a particular set of tools and perspectives for
Background

handling the task of evaluating programs or other kinds of intervention. In the field of injury prevention, evaluation of intervention has been influenced by the health sciences rather than the social sciences. Randomized clinical trials, epidemiological models to take into account population level variables in evaluation projects, and the division of program development into a sequence of evaluation phases that emphasize the distinction between efficacy and effectiveness are usual and recommended (CDC, 1992).

To date, several evaluations of bicycle safety helmet promotion programs have been published (Wood, 1988; DiGuiseppi, 1989; Moore, 1990; Cushman, 1991; Morris, 1991; 1994; Coté, 1992; Towner, 1992; Parkin, 1993; 1995; Dannenberg, 1993c; Schneider, 1993; Rivara, 1994; Rourke, 1994; Liller, 1995; Ekman, 1997; Scuffham, 1997; Britt, 1998; Hendrickson, 1998). Program effectiveness has been assessed with indicators including helmet purchase and ownership (Cushman, 1991; Parkin, 1993; Dannenberg, 1993c; Schneider, 1993; Rourke, 1994), evolution of helmet use (Wood, 1988; DiGuiseppi, 1989; Coté, 1992; Morris, 1991; 1994; Parkin, 1993; Ekman, 1997; Britt, 1998), and, to a lesser extent, evolution of the prevalence of bicycle-related head injuries (Wood, 1988; Cameron, 1994; Rivara, 1994; Scuffham, 1997).

Many of the evaluations relating to community-based programs were conducted based on designs that presented some weaknesses that call the validity of the results into question. Some of these studies did not have a control group (Wood, 1988; Dannenberg, 1993b; Morris, 1994; Rivara, 1994); or had a control group that was not entirely comparable to the intervention group (Dannenberg, 1993b) or presented intervention and control groups that overlapped substantially (Parkins, 1993). As for other studies, the small number of observations would suggest a cautious interpretation of the results (Morris, 1991; Coté, 1992).

The bulk of those evaluations report an increase of helmet use over time (Wood, 1988; DiGuiseppi, 1989; Bergaman, 1990; Moore, 1990; Morris, 1991; Coté, 1992; Parkin, 1993; Liller, 1995) and significant reductions in bicycle-related head injuries (Wood, 1988; Cameron, 1994; Rivara, 1994; Scuffham, 1997).

State of knowledge: Although bicycling offers numerous benefits, it is also associated with non-negligible injury-related mortality and morbidity, in particular among children. Several studies have shown that helmet use decreases the risk of head injury while cycling, and educational programs targeted to children have shown significant increases in voluntary helmet use.

So far, program evaluations have not dealt much with their progressive impact on factors e.g. individual attitudes, social norms despite their determinant effect on individual motivation to wear and own a helmet. In addition, the evaluations on hand say nothing about the relative distribution of their benefits in terms of helmet use and head-injury prevention based on factors such as children’s age and sex, or
socioeconomic circumstances of the neighbourhood. It is also unclear if effects remain after a program is ended.

From a public health standpoint, information of that kind can be of great importance. It can serve as a basis for the determination of those groups or areas where bicycle helmet wearing is less of a practice or where its preventive effect is less obvious so that programs can be adequately adjusted in terms of strategies and activities and, thereby, program objectives can be reached most effectively and have better durability.

1.6 Bicycle helmet promotion program in Montérégie region

1.6.1 Theoretical foundations of the program

The development of the "Mon Vélo-casque c’est sauté" (or. "Bicycle Helmets Are IN") program was based on different models usually used in health promotion: individual health behaviour (Theory of Reasoned Action) and community and group models of health behaviour change (community organization, diffusion in innovation theory and communication theory).

According to the Theory of reasoned action model (Fishbein, 1975; Ajzen, 1980) behavioural intention to adopt behaviour is the best predictor of that behaviour. With this in mind, a pre-implementation study based on this theory was conducted to identify the factors that were most likely to influence children’s intentions to use a helmet (Otis, 1992) in the target community. The findings of the study inspired the advocacy messages adopted, and oriented the development of the educational activities in place during the program. Moreover, the persuasive communication strategies used for the media campaign respected the notions developed by Flay (1981), i.e. they took into account the degree of awareness, comprehension and buy-in to the message and they used a credible, attractive source and many channels of diffusion. According to Roger’s theory, the diffusion of an innovation (Rogers, 1983) is based on the adaptation of various means of action suited to the characteristics of the different categories of adopters targeted. Thus, for example, the promotion of an innovation (here bicycle helmet) must be adjusted to the socioeconomic level and the psychological characteristics of those being targeted, otherwise there is a risk that the innovation will be adopted in an unequal fashion. Finally, the principles of social action defined by Rothman (1979) inspired the implementation and actualization of the program. To start off, the health professional played the role of expert, defining the needs, priorities and
objectives of the program. Following this, he acted as an intermediary or agent of change between the various levels so as to elicit the involvement of the community in the implementation of the program.

Theories can be used most effectively if they are integrated within a comprehensive planning framework. The framework provides a structure for applying theories so that the most appropriate intervention strategies can be identified and implemented. With respect to the program that interests us, combining theories was accomplished with a sound framework often used in health-promotion work the PRECEDE-PROCEED intervention-planning model developed by Green (1991). The PRECEDE and PROCEED work in tandem, providing a continuous series of steps or phases in the planning, implementation, and evaluation process. It suggests that health education planning could be conceived as a diagnostic approach, starting with the ultimate quality of life goal and ending with health promotion programme. The PRECEDE (acronym for predisposing, reinforcing, and enabling causes in educational diagnosis and evaluation) framework takes into account the multiple factors that shape health status and helps the planner arrive at highly focused subsets of those factors as targets for intervention. These factors are predisposing factors (attitudes, beliefs, values, and knowledge), enabling factors (skills, resources, cost, and availability) and reinforcing factors (reward and punishment). PRECEDE also generates specific objectives and criteria for evaluation. The PROCEED (acronym for policy, regulatory and organizational initiatives) framework provides additional steps for developing policy and initiating the implementation and evaluation process.

Figure 1 introduces the Green model and shows that educational programs constructed with this framework will integrate different theories and contain a combination of several interventions, each representing one or several components of PRECEDE-PROCEED. In addition, it proposes three evaluation domains: process evaluation, impact evaluation, and outcome evaluation.
1.6.2 Program contents and strategies

The program “Mon Vélo-casque c’est sauté” (Bicycle Helmets Are IN), in place during the period from 1990 to 1993 was education and population-based, and formed part of a five-year plan aimed at reducing head-injury mortality and morbidity in the entire Montérégie region. Montérégie is one of 18 administrative regions in the Province of Québec, Canada and it is located on the south shore of the St. Lawrence River adjacent to the island of Montreal and covers an area about 100 x 150 kilometres. It has a population of 1.2 million living in more than 230 municipalities and three cities of over 50,000 inhabitants. It is thus largely a suburban and rural area.
The program targeted elementary school children, aged 5 to 12 years, attending both French and English public schools in the Montérégie region (approximately 380 schools and 140,000 children). Its objective was to increase the helmet-wearing rate from 1.3% to 20% in four years.

The program started in 1990, and its activities were repeated every year from April to August (the spring and summer bicycling season) through to 1993. Standard educational activities to modify attitudes, beliefs and values with regard to helmet use were undertaken, mainly in schools during May and June. Complementary community-based activities, focusing on facilitating helmet acquisition and reinforcing helmet use, were pursued from April to August by police officers, social clubs, sporting-goods retailers, municipal recreation departments, and the various stakeholders involved in cycling events.

Interventions with regard to both personal and environmental factors included classroom exercises and support (integrated into the course curriculum for each grade) to modify attitudes and decrease barriers, use of formal (public service announcements) and informal channels (community announcements at social and recreational events) to disseminate the program and increase awareness, technical instruction on how to buy and properly wear a helmet, the provision of social opportunities to cycle in groups so as to develop social and normative support, and enhanced marketing of the product (helmet) with regard to price, retail outlets and promotion. One particularity 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). The program development even included contacts with people and organizations with responsibilities at the policy, regulatory and organizational levels following Green’s model (see Figure 1). The organizations contacted were the Québec Automobile Insurance Board, the Canadian Medical Association and the National Injury Control Committee. Financial assistance from the Québec Automobile Insurance Board is one example of an agreement with these organizations.

Figure 2 summarizes the different activities undertaken during the program and how they related to predisposing, enabling and reinforcing factors in line with the PRECEDE-PROCEED model (Green, 1991).

To provide information for the improvement, modification, or general administration of the program an evaluation of the process was conducted annually (Farley 1991; 1992; 1993; 1994). The information intended to evaluate the process was obtained through the use of questionnaires self-administered by the partners...
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Factors</th>
<th>Activities</th>
<th>Process/Implementation data</th>
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Predisposing factors
- Raise parental and child awareness
  - Elementary school and community setting
    - Promotional posters
    - Pamphlets for parents
    - Educational guides for teachers and municipal recreation departments
    - Themes for discussion, and competitions
    - Exposure to mass media
- Theory of reasoned action
- Diffusion of innovation
- Enabling factors
- Decrease the cost of helmets
- Increase availability of helmets for school-age children
  - School and community setting
    - Discount coupons $5, $10
    - Bulk buying with trade fairs for parents
    - Distribution of free helmets
  - Retailers (110 stores)
    - Small-size approved helmets
    - Instructions for wearing
- Reinforcing factors
- Provide incentives to children for helmet use
- Reduce perception of negative peer pressure
  - Community setting
    - Reward
    - Punishment
- Activities were concentrated during the spring and summer each year from 1990 to 1993
  - On average 216 schools and 250 agencies participated in the program each year
  - 12,214 posters, 319,944 pamphlets and 4,965 educational guides were distributed
  - Exposure to the program
  - Among the 1,089 pupils who completed the evaluation questionnaire at the end of the program:
    - 85% mentioned having heard about the program
    - 60% learned of the program in school, 42% of whom participated in three activities
    - 50% participated in community-based activities, 49% of whom participated in two activities

Promotion
- Much repetition in several sources (media, school, community)
- High quality production of materials

Social action model
Bicycle Helmet Committee
- to mobilise local involvement in activities
  - Representative from:
    - School boards
    - Optimist clubs
    - Police association
    - Municipal recreation departments
    - Sporting associations
    - Public health department

Policy
- Lobby over governmental groups or organisations

Figure 2. Summary of the bicycle-helmet program based on the precede model and of its process evaluation (adapted from Farley et al., 2003)
or completed during telephone interviews. For the schools, the compilation of evaluation forms returned by the teachers served to estimate their participation in the educational activities. The following variables were measured: number of people made aware of the program, participation of the various settings (intensity and use of promotional tools, quantity of material distributed), the population reached, satisfaction of those aware of the program and interest in becoming involved at a later date, coverage of the territory by the activities and accessibility of helmets (helmet sales, helmets given away, distribution of incentives to purchase helmets).

During the four years of the program, about one out of two schools (200 out of 380) and 250 agencies participated in the program each year: 12,214 posters, 319,944 pamphlets, 4,965 educational guides, 72,672 discount coupons were distributed and used throughout the Montérégie region and over 4,600 bicycle helmets were given to children as a gift. Considering exposure to the program, 85% of responding students had a general awareness of the program. Close to 6 in 10 learned of the program in school and 1 in 2 participated in community-based activities. Annual costs of the program per targeted child were estimated at 0.70 $US.

In addition to the evaluation process which aimed to find out the extent of the activities carried out, other types of evaluation were conducted as suggested by Green (see Figure 1). Following this model, behavioural changes (impact evaluation) were measured in two manners. A first measure evaluates the changes reported in terms of attitudes, norms and motivation to use a helmet, taking into account the fact that the acquisition of a new behaviour (helmet use was practically non-existent at the time when the program was developed) occurs slowly during the first years of an education program, and that it is possible to observe no effect on helmet use in the short term. The second measure concerns the changes observed in terms of helmet use itself.

As for evaluation of the impact of the intervention on head injuries (outcome evaluation), the data on hospitalization following a bicycle accident over a period of at least ten years allowed for studying the evolution of head injuries, while also enabling us to obtain a sufficient number of cases and to generate sufficient statistical power.

Figure 3 gives a general overview of the whole project, i.e. of the intervention (Xs and Xc), of the different measures (pre and post) that allowed for evaluation of the program « Mon vélo-casque c’est sauté », and when they were carried out. Here we can visualize the studies and locate those that make up this thesis, i.e. Studies 1 (O_q) and 2 (O_o) relative to the impact evaluation and Studies 3 and 4 (O_hi) relative to the outcome evaluation.
### Grade Level

<table>
<thead>
<tr>
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<td>O’q O’o</td>
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<td>Comparison community</td>
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</tr>
<tr>
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</tbody>
</table>

From 1988 to 1997

O hi

---

Xc : Intervention in the community, Xs: Intervention at school
O’q : Preliminary investigation on attitudes, norms and behaviours (Otis, 1992)
O q : Impact evaluation: effects on behavioural intention and ownership (Study 1)
O o : Impact evaluation: effects on helmet use (Study 2)
O hi : Outcome evaluation: impact on head injury (Studies 3, 4)

**Figure 3. Organisation of the program evaluation over time**
2 MAIN AIM AND OBJECTIVES

The aim of the thesis is to assess the relative impact and outcome of a population-based safety promotion program based on voluntary behavioural change among children aged 5-12 years. Consideration is paid to children’s age and sex as well as to individual and area-based socioeconomic status (SES).

Secondary objectives are:

- To examine the effect of the bicycle helmet program on motivating children to own and use a bicycle helmet.
- To assess the differential impact of the program on helmet use in different segments of the population (i.e., age and sex group, individual SES).
- To assess the differential outcome of the program on head-injury risks in different segments of the population (i.e., age and sex group, area-based SES).
- To assess whether there is a relationship between the impact of the program on helmet use and its impact on injury risks.

For each paper the objective was:

I. To measure behavioural changes in children’s intention to wear and to own a helmet in relation to the length of time the program has been in place.

II. To measure the impact of the program (wearing a helmet) on different groups of children, different bicycle-riding and living circumstances in relation to program duration.

III. To assess the impact of the program on the occurrence of bicycle-related head injuries based on sex and age group of the child.

IV. To assess the differential impact of the program on the occurrence of bicycle-related head injuries according to the socioeconomic status of the children living area.
3 MATERIALS AND METHODS

3.1 Evaluation design

The evaluation plan for the program encompassed all elements affecting the achievement of the program goals: behavioural intention to adopt helmet wearing, helmet use, and head injuries. Achievements of the program were determined by changes in behavioural intention (self report – Study 1), helmet use (direct observation – Study 2) and head injury risk reduction (Studies 3 and 4).

The study population was that of children residing in the Montérégie region during 1990 to 1993 and aged 5-12 years (n=138,820 in 1996). Children residing in another region about 40 km north of Montréal (The Metropole of the Province of Quebec) composed the comparison community (n=83,500 in 1996). This region was used as a comparison group because of its similarity to the study population in terms of distance from Montréal, population age structure, and proportion of the population below the low-income threshold and because it did not have an equivalent program.

In three of the four studies (Studies 2, 3, 4) the same study population and comparison community were used. For Study 1, the study population included approximately 50,000 French-speaking children in Grades 4 and 5, and 6 (aged 8 to 12) who could answer a self-administered questionnaire, attending 244 schools in the Montérégie area and the comparison community included 6,513 children of the same age residing in municipalities from the north Montréal region described above.

Figure 4 summarizes the main elements of the design, material and methods of the four studies forming the thesis, one study at a time (columns 2 to 5 in Figure 4).

3.2 Behavioural change: two measurements

Behavioural changes were measured using two sets of data, one based on self-reports and the other one, on direct observation: a questionnaire and an observational grid were developed accordingly. The questionnaire dealt with determinants of intention to use a helmet and helmet ownership. The observational grid focused on direct observation of children’s helmet use and the characteristics related to its use.
<table>
<thead>
<tr>
<th>Methods</th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study population</td>
<td>Children aged 8-12 years (n= 50,000)</td>
<td>Children aged 5-12 years (n=138,820)</td>
<td>Children aged 5-12 years (n=138,820)</td>
<td>Children aged 5-12 years (n=138,820)</td>
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<tr>
<td>Research design</td>
<td>Pre-experimental, static group comparison</td>
<td>Quasi-experimental, non-equivalent control group</td>
<td>Quasi-experimental, non-equivalent control group</td>
<td>Quasi-experimental, non-equivalent control group</td>
</tr>
<tr>
<td>Comparison community</td>
<td>Children of the same age residing in municipalities in another region about 40km north of Montreal, with similarities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools/instruments</td>
<td>Self-administered questionnaire</td>
<td>Observational grid</td>
<td>Inpatient register from standardized provincial government (full coverage)</td>
<td>Inpatient register from standardized provincial government (full coverage)</td>
</tr>
<tr>
<td>Sociodemographic variables</td>
<td>Sex, age, grade level</td>
<td>Sex, age, socio-economic level</td>
<td>Sex, age, socio-economic level</td>
<td>Sex, age, socio-economic level</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Intention to wear a helmet</td>
<td>Helmet use</td>
<td>Bicycles related injuries – hospitalization for head injuries and other injuries</td>
<td>Bicycles related injuries – hospitalization for head injuries and other injuries</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>Hierarchical logistic regression</td>
<td>Multiple logistic regression</td>
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<td>Odds ratios</td>
<td>Odds ratios</td>
<td>Rate ratios</td>
<td>Rate ratios</td>
</tr>
</tbody>
</table>

Figure 4. A schematic view of the studies encompassed by the thesis
3.2.1 Questionnaire data

The questionnaire was developed according to the planning framework PRECEDE (see section 1.6.1). Considering predisposing factors (attitudes, beliefs, values and knowledge) and reinforcing factors, the Theory of Reasoned Action (Fishbein, 1975) was used to determine questions. This theory is useful for investigating psychosocial factors that influence motivation to participate in behaviours that enhance health. It stipulates that the intention to engage in a behaviour is governed by attitude toward the behaviour and by subjective norms. These determinants correspond to different classes of outcome expectations. Attitude is measured in terms of perceived outcomes, and the value placed on those outcomes. Subjective norms are measured by perceived social pressures by significant others, and one’s motivation to comply with their expectations. Subjective norms correspond to expected social outcomes for a given behaviour. The main constructs of the theory were measured: behavioural beliefs (attitude: perceived advantages and disadvantages relating to bicycle helmet use), normative beliefs (social norms: persons who they thought would agree and those who would disagree with bicycle helmet use), intention to wear a helmet, and the measures suggested by the theory were respected.

The questionnaire included twenty questions, the majority of which were closed. The preliminary questionnaire was submitted to an educational consultant, an evaluation expert, as well as three elementary school teachers for comments on its design, length, and answer alternatives. It was then pre-tested with a group of students in Grades 4, 5 and 6. After corrections, the questionnaire was resubmitted to three classes at each grade level (81 children). Internal consistency of the instrument was verified by calculating the Cronbach alpha coefficient for each of the study constructs. The measures varied from 0.33 to 0.76. Some items were reworded, some alternatives were eliminated, and the final questionnaire presented more satisfactory psychometric qualities; internal consistency of the constructs ranged from 0.68 to 0.94 in 1991 and from 0.66 to 0.94 in 1993.

In the final version of the questionnaire, the following concepts were operationalized in the manner described below:

- Behavioural beliefs (attitudes) were measured by asking the child to indicate the probability of agreeing with certain beliefs: three advantages (wearing a helmet is fun, it looks sporty, and it is safe) and four disadvantages (wearing a helmet is a bother, ugly, looks ridiculous, would make the user appear to be "chicken"). A four-point scale was used ranging from not at all (0) to completely (+3) for the positive items and from (0) to (-3) for the negative items. The scores for each item were totalled for the overall score indicating the strength of behavioural
beliefs, with a possible range from –12 to +9. The Cronbach alpha was 0.85 in 1991 and 0.83 in 1993.

- **Normative beliefs (social norms)** were measured by asking the child to what extent they thought their father, mother, friends, teachers would be supportive of their wearing a bicycle helmet each time they rode a bicycle. A three-point scale was used for each of the items ranging from against (-1) to for (+1). The sum of each of the items gave the overall score, from –4 to +4. The Cronbach alpha was 0.72 in 1991 and 0.69 in 1993.

- **Enabling factors** allowed for measuring if the following four strategies could encourage children to wear their helmets every time they rode a bicycle: a safe place to store helmet in school, a law requiring helmet use, nicer looking helmets, or an anti-theft system in which helmets could be attached to the bicycle. Each of these items was measured on a three-point scale ranging from not at all (1) to a lot (3). The total score for this variable could have ranged from 4 to 12 and its internal consistency measured by the Cronbach alpha was 0.68 in 1991 and 0.66 in 1993.

- **Intention to wear a helmet** every time the child rode a bicycle was measured for seven circumstances: close to home, to go to the store, to go to the park, on a bicycle path, to go to school, to go riding with friends and with family. Each of the items was measured on a scale ranging from never (1), occasionally (2), often (3) to always (4). The overall score for intention ranged from 7 to 28. The Cronbach alpha was 0.94 in both 1991 and 1993. For the purpose of logistic regression analysis, this score was sorted into two categories: low intention (7 to 18) and high intention (19 to 28).

- **Helmet ownership** was verified by one question where a positive response was coded 1 and a negative response, 0.

In the fall of 1991 and 1993, the self-administered questionnaire was completed by the students during class time. The same instructions were repeated to each of the groups. However, it proved necessary to read the questions to the Grade 4 students and to have all of them complete each question before moving on the next one. The questionnaire took approximately 20 minutes to complete.

### 3.2.2 Observation grid

The observation grid was developed, validated, and pre-tested. The variables considered were inspired by other observational surveys (DiGuiseppi, 1989; Cushman, 1990) and concerned helmet use, rider characteristics and took
observational circumstances into consideration. For helmet use, the components of correctness and helmet effectiveness, i.e. helmet approved by a certifying organization, were taken into account. Two rider characteristics were considered, sex and age of the child, and they were approximated by the observer (see below). The observation circumstances included year, municipality, observation area, date, time of day, day of the week and group (target or comparison community). Observation area included bicycle path or lane, school road, residential and commercial streets in order to represent bicycle-riding and helmet wearing behaviours.

The observation strategy was developed in the following manner. We made a list of the elementary schools in the 25 municipalities chosen randomly. A perimeter was traced around each school (observation area) and the observer had to observe where children commonly ride, including specific school roads, parks, bicycle path or lane, swimming pool, libraries. A migratory observation method was used by posting "solo observers" at fixed sites for short periods, then having them rotate to the next predetermined fixed site.

Observers were trained to learn the location and boundaries of the observation area, correct use of instrument and practice needed to accurately estimate rider age. They were instructed to stay at a single site (bicycle path or lane, school road, near park or swimming pool, residential and commercial streets) for no more than 30 minutes and in an observation area for no more than 90 minutes. Observers were expected to respect procedures guaranteeing the ethics of the intervention and specifically to respect parental directives. Indeed, in no case would the observers address the children directly, as it is customary for parents to advise their children not talk to strangers.

The observational survey was conducted each year (1991, 1992, 1993) to measure helmet use among children. Observation sites and methodology were the same each year.

### 3.2.3 The design and sampling strategies

The questionnaire survey was based on a pre-experimental static group comparison design (Campbell, 1966) repeated at the second and fourth years after the program kick-off, with a non-randomized control group.

A two-stage cluster sampling (1st step, schools; 2nd step, classes) stratified according to grade level and group (target and comparison communities) was used. The calculation of the number of observations required is based on the hypothesis of multiple regression analyses. Thus, with a threshold of significance of 0.01 and a possibility of a maximum of 10 independent variables, a sample size of 555 students
Materials and methods

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per group studied was sufficient to detect a multiple coefficient of determination multiple (R2) of 0.05 with a test strength of 0.95 (Cohen, 1988).

A total of 22 schools were selected at random (target community and comparison community), and then in each of the schools one class per grade level was chosen randomly for a total of 68 classes. In 1991 and 1993, the target community had 1,008 and 1,089 students and the comparison community, 652 and 675. No significant difference was observed between the experimental group and control groups for 1991 for the variables of age, sex, and grade level. In 1993, only the average age differed slightly: it was 10.25 years in the target community and 10.44 years in comparison community. Generally speaking, the proportion of girls and boys was similar and the sample was evenly divided among the three grade levels.

A quasi-experimental design (Campbell, 1966) with repeated measures and a non-randomized control group was used for observational study.

The sample size was calculated in relation to the expected prevalence of helmet wearing in the target community and the comparison community, to the risk of type 1 error (α) and to the risk of type 2 error (β). Considering an expected prevalence of helmet wearing among the children in the comparison community of 4% and of 8% in Montérégie and a capacity to detect a difference of 2% with a type 1 error (α) of 5% and a strength of (1−β) fixed at 90%, the number of observations was estimated at 296 for each of the groups.

A total of 25 municipalities were selected at random (target community and comparison community). In 1991, 1992 and 1993, the target community had 1,566, 1,785 and 2,736 observations and the comparison community, 518,411 and 1,096. Of the 8,112 children observed, 6,087 were in municipalities exposed to the intervention. The majority were boys (5,106), and two-thirds of them fell into the 9- to 12-year age bracket (5,583).

3.2.4 Analysis

Questionnaire-based study: It was possible to increase helmet use with an increase in children’s motivation to use a helmet and an increase in the proportion of children owning one through modification of their attitudes (behavioural beliefs), their perceived social pressure (normative beliefs), etc. Hierarchical logistic regression was used to verify the overall effect of the program on intention to use a helmet and on helmet ownership by including in the model exposure to the program (independent variable), sex and age (controlled variable), on the one hand, and intermediate psychosocial variables likely to influence intention (behavioural beliefs, normative beliefs, enabling factors). These analyses were conducted first on
the 1991 data to understand the effect of the program after two years in operation, and then on the 1993 data to evaluate the effect after four years. The two sets of data were then merged (1991-1993). The time factor (i.e. duration of the program) was added to the different models and all interactions, such as interaction between the length of time the program had been in operation and exposure to it, were verified.

**Observation-based study:** For the analyses, children were divided into two categories according to their probable age (5 to 8 years old and 9 to 12 years old). The proportion of the population below the low-income threshold as defined by Statistics Canada (2001) was used as a proxy for the variable of socioeconomic level. Municipalities were divided into two categories, "average-rich" or "poor," depending on whether this proportion was greater than or less than 20%; all of the children from any given municipality were assigned to a category.

The data were analyzed in two stages. At first, the evolution of helmet use was examined in the target community and in the comparison community 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) for 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. In order to increase estimates and to document program effectiveness across years, program data that included several years of observation (1991, 1992, 1993) were merged after one temporal variable, i.e. "Year" had been created to take into account the length of time the program had been operating and the presence of a possible secular trend. Helmet use was the dependent variable of the model and the group (target or comparison) was the independent variable being studied. The other independent variables were: age, sex, bicycle riding circumstances (school road, local street, bike path or lane), municipality, time of the observation, period of the week, year of the 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, seven interaction terms were included in the model (between the group in question and each of the seven other independent variables).

The parameters of the model were estimated using the Egret software and the contribution of each of the variables was evaluated using the maximum likelihood test. The software allowed for splitting the ordinal variables such as the observation site or year into dichotomous variables: one ordinal variable at m value results in m-1 dichotomous variables.
3.3 Impact on injury-risk levels (Studies 3 and 4)

3.3.1 Design and material

Studies 3 and 4 used the same methods and data sources. A quasi-experimental design (Campbell, 1966) was used, covering the pre- and post-implementation periods as well as the program period itself. Since bicycle-related mortality was low during the study period 1988-1996 (about two per year), the evaluation focused on serious bicycle injuries, i.e. injuries that resulted in hospitalization for at least one night (excluding death). Hospitalization data were obtained from MedEcho for the years 1988 to 1996. MedEcho is a standardized provincial government in-patient registry that offers full coverage of hospitals in Québec.

“Head injury” was defined as proposed by Thompson et al. (1989), i.e., covering any area of the head that a helmet might be expected to protect. Accordingly, following the WHO International Classification of Diseases, Version 9 (1977), all cases of hospitalization for trauma codes (800-999), and – in particular – those for head and facial trauma codes 800-804, 850-854, 872, 873.0, 873.1, 873.8 and 873.9 (relating to bicycle collision codes 813.6, 821.6, and 826.1), were extracted from MedEcho for Montérégie residents and for members of the comparison community. For each injury, sociodemographic variables were also available (age, sex and municipality of residence of the victim).

During the study period, a total of 1,300 children aged 5 to 12 years were hospitalized following a bicycle collision, 842 from the target community, and 485 in the comparison community. In about four in ten cases, the main cause of hospitalization was head injury. Of these, 68% were incurred by boys and 53% by older children. In 41% (537) of cases, the main cause of hospitalization was a head injury; in 22%, the child lived in a poor municipality.

Table 2 describes the study population, the number of children (5 to 12 years old) admitted to hospital for all bicycle accidents, percentage of head injuries and other injuries with total of study population comprising the target and comparison communities, 1988-1996, was reported for each variable.

It can be noted that during the 9-year period 1988-1996, annual injury incidence rates for head injuries fell over time in the target community, but not in the comparison community. Such a downward trend was not observed for others injuries (see Figure 5).
Table 2. Distribution of hospital admissions for bicycle accidents among children (5 to 12 years old) by period, community and groups of children

<table>
<thead>
<tr>
<th>Period</th>
<th>Target community</th>
<th></th>
<th></th>
<th></th>
<th>Comparison community</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Boys %</td>
<td>Girls %</td>
<td>5-8 yrs %</td>
<td>9-12 yrs %</td>
<td>Average-rich %</td>
<td>Poor %</td>
<td>Boys %</td>
<td>Girls %</td>
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<tr>
<td>Before the program 1988-90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Head Injuries</td>
<td>49</td>
<td>52</td>
<td>58</td>
<td>44</td>
<td>50</td>
<td>51</td>
<td>37</td>
<td>34</td>
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<tr>
<td>Other injuries</td>
<td>51</td>
<td>48</td>
<td>42</td>
<td>56</td>
<td>50</td>
<td>49</td>
<td>63</td>
<td>66</td>
</tr>
<tr>
<td>Total 100%</td>
<td>211</td>
<td>103</td>
<td>138</td>
<td>176</td>
<td>230</td>
<td>83</td>
<td>106</td>
<td>50</td>
</tr>
<tr>
<td>During the program 1991-93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Injuries</td>
<td>41</td>
<td>42</td>
<td>48</td>
<td>37</td>
<td>43</td>
<td>39</td>
<td>42</td>
<td>32</td>
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<tr>
<td>Other injuries</td>
<td>59</td>
<td>58</td>
<td>52</td>
<td>63</td>
<td>57</td>
<td>61</td>
<td>58</td>
<td>68</td>
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<tr>
<td>Total 100%</td>
<td>186</td>
<td>104</td>
<td>124</td>
<td>166</td>
<td>214</td>
<td>75</td>
<td>116</td>
<td>41</td>
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<tr>
<td>After the program 1994-96</td>
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<td></td>
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</tr>
<tr>
<td>Head Injuries</td>
<td>35</td>
<td>36</td>
<td>37</td>
<td>34</td>
<td>35</td>
<td>33</td>
<td>41</td>
<td>36</td>
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<td>Other injuries</td>
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<td>64</td>
<td>63</td>
<td>66</td>
<td>65</td>
<td>67</td>
<td>59</td>
<td>63</td>
</tr>
<tr>
<td>Total 100%</td>
<td>165</td>
<td>78</td>
<td>101</td>
<td>142</td>
<td>182</td>
<td>58</td>
<td>98</td>
<td>47</td>
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<tr>
<td>Total number of children admitted to hospital for all bicycle accidents, 1988-1996</td>
<td>562</td>
<td>285</td>
<td>363</td>
<td>484</td>
<td>626</td>
<td>216</td>
<td>320</td>
<td>138</td>
</tr>
<tr>
<td>Study population</td>
<td>71,076</td>
<td>67,744</td>
<td>69,688</td>
<td>69,132</td>
<td>111,370</td>
<td>27,450</td>
<td>42,600</td>
<td>40,929</td>
</tr>
</tbody>
</table>
Materials and methods

3.3.2 Analysis

The analyses were performed according to sex, age group (5-8 and 9-12 years) (Study 3) and category of municipality (Study 4). In the latter case, two categories of municipalities were considered, poor and average-rich. The criteria applied to discriminate between the two categories was based on area measures which assess an important aspect of exposure to certain socioeconomic conditions proposed by Haan et al. (1987). Municipalities with a proportion of households below the low-income threshold equal to or greater than 20%, as defined by Statistics Canada (2001), and according to the 1996 census, were categorized as poor (98 municipalities) and those with a proportion less than 20% were categorized as average-rich (210 municipalities).

The number of municipalities categorized as poor was slightly lower than in the target community (24 compared with 27), but these municipalities comprised more than twice as many children from the target age group (27,450 and 10,400 children, respectively). The number of municipalities categorized as average-rich was more than twice as high in the target community (186 compared with 71), and comprised
nearly twice as many children from the target age group (111,370 compared with 73,129).

In both studies, 3 three-year periods were considered, covering the pre-implementation (1988-1990), the implementation (1991-1993), and the post-implementation (1994-1996) phases of the program. The number of exposed children during each period, and for each category of sex, age group and municipalities, was assumed to be that of the post-program period (1994-1996) – for which census data were available (Statistics Canada, 2002) (see Table 2). Considering the 1991 census from Statistics Canada and population estimates from administrative regions, the number of children aged 5-12 years decreased by 2% in the target community, whereas it increased by 7.5% in the comparison community.

Three sets of analyses were conducted so as to address the following questions:

1. Did the program reduce bicycle-related head injury risks by sex and age group, and socioeconomic category of municipality over time?

Comparisons were made between periods, using the pre-implementation period as reference for the target and the comparison community separately. Differences in the risk of bicycle-related head injuries, expressed as incidence of hospitalization per 1,000 children, were measured using rate ratios (RRs) with 95% confidence intervals (CIs) by sex, age group and category of municipality.

2. Did intra-group differences (between communities) by sex, age and socioeconomic category of municipality change between periods with regard to bicycle-related head injuries?

Injury rates were compared between the target and the comparison community within period and group (sex, age, socioeconomic category). Again, differences in the risk of bicycle-related head injuries, expressed as incidence of hospitalization per 1,000 children, were measured using rate ratios (RRs) with 95% confidence intervals (CIs) by sex, age group and category of municipality of similar socioeconomic status.

3. Did the risk of bicycle-related injuries other than those to the head change, considering 1 and 2 above?

Similar analyses to the two mentioned above were performed with regard to bicycle-related injuries other than those to the head. These were designed to ascertain whether changes in risk exposure might have occurred, and conducted in light of the debate concerning the possibility of a reduction in bicycle use due to the implementation of a bicycle-helmet-wearing campaign (mainly in the context of law enforcement) (Robinson, 1996).
4 RESULTS

4.1 Changes in self-reported helmet ownership and intention

Helmet ownership: During the needs assessment study in 1989, only 4% (34/797) of the children reported owning a bicycle helmet. After the second year of the programme, 1 in 4 (26%) children reported owning a helmet, and after the fourth year, the figure was 1 in 2 (56%) in the target community. The presence of a secular trend was estimated by examining the situation in the comparison community data where helmet ownership also increased between 1991 and 1993, from 14% to 36%.

Independent of the year, helmet ownership was higher among girls and among the youngest children in the target community. Before the program, there was no significant difference between the proportion of boys and girls who owned a helmet.

In the total sample (1991-1993), it was observed that at least twice as many children exposed to the program owned a helmet (OR = 2.09, p < 0.0001). Independent of exposure to the program, time was the most important predictor of helmet ownership. Indeed, close to five times as many children who answered the questionnaire in 1993 owned a helmet (OR = 4.83, p < 0.0001) compared with 1991. Other variables included in the logistic regression model improved prediction of ownership. Thus, children with more positive behavioural beliefs (OR = 1.09, p < 0.0001) and more favourable normative beliefs (OR = 1.26, p < 0.0001) were found more among the group of owners. Moreover, there were more children who valued enabling factors (laws, place for storing helmets, nicer looking helmets, anti-theft system) and older respondents in the group of non-owners (OR = 0.91 and 0.80 respectively, p < 0.0001). It was clear that the variables of exposure to the program and normative beliefs had a greater influence on helmet ownership in 1993 than they did in 1991.

Intention to wear a helmet: Considering intention to use a helmet every time the children ride a bicycle, for all of the respondents from 1991-1993, six variables had a significant effect, with exposure to the program being the principal predictor (OR = 1.40, p < 0.001), together with the child’s sex (OR = 1.40, p < 0.001). Children from the target community and girls were over-represented in the group of children with high intention. A high intention was also predicted by more positive behavioural beliefs (OR = 1.35, p < 0.0001) and a greater agreement
Results concerning enabling factors (OR = 1.32, p < 0.001). Oldest children were found in excess among the group with low intention (OR = 0.77, p < 0.0001). Time, however, (either two or four years after the program was launched) did not have any effect on intention.

Exposure to the program and a number of some other variables such as behavioural beliefs and enabling factors were more associated with high intention in the 1991 group than in that of 1993. By contrast, the influence of normative beliefs on intention proved to have the same importance both in 1991 and 1993 (OR = 1.36, p < 0.0001).

In sum, the program increased children's motivation to use bicycle helmets as well as the number of children owning one. The most remarkable results were found among girls and among young children.

4.2 Observed behavioural changes

The following figures illustrate trend in helmet use over time, all children aggregated (Figure 6a), by sex (Figure 6b), by categories of age group (Figure 6c), by categories of municipality (Figure 6d) and by bicycle-riding circumstances (Figure 6e). In the target community, the helmet-use rate rose to 1 in 10 after the second year of the program, and to more than 1 in 3 after the fourth year. The rate also increased in the comparison community, tripling between 1991 and 1993 (see even Table 3). In sum, helmet use rose from year to year regardless of municipality, bicycle-riding circumstances or age and sex of the child.

Girls, children in the younger age group, and children riding on bicycle paths or lanes were over-represented among voluntary helmet users (Table 3). In the Montérégie, helmets were worn more by children observed in the average-rich municipalities than those observed in the poor ones. Opposite results were observed in the comparison community where children of poor municipalities were over-represented among voluntary helmet users.

Preliminary regressions were carried out to select the variables for the final model. The time of observation (morning, afternoon, evening) and period of week (weekday, weekend) variables and their interaction terms made no significant contribution and were omitted in subsequent analysis. The coefficients assigned to the following terms were also not significant: Study population X Sex (P = .4), Study population X Age (P = .64) and Study population X Years (P = .53 and P = .24). This suggested that the effect of the program did not differ between girls and boys, age groups, or different years. These terms were also eliminated from the final model.
Results

$a$

$b$

$c$
Figure 6. Trend in bicycle helmet use over time in the target and comparison community: a) all children aggregated, b) by sex, c) by age group, d) by categories of municipality, e) by riding circumstances.
Table 3. Observed helmet rates in the target and the comparison communities

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target (n=1566)</td>
<td>Comparison (n=518)</td>
<td>Target (n=1785)</td>
</tr>
<tr>
<td>Boys</td>
<td>8.8</td>
<td>6.6</td>
<td>18.9</td>
</tr>
<tr>
<td>Girls</td>
<td>11.9</td>
<td>4.3</td>
<td>19.2</td>
</tr>
<tr>
<td>9-12 years old</td>
<td>13.3</td>
<td>12.5</td>
<td>21.7</td>
</tr>
<tr>
<td>5-8 years old</td>
<td>19.2</td>
<td>2.4</td>
<td>17.2</td>
</tr>
<tr>
<td>Local streets</td>
<td>28.5</td>
<td>2.8</td>
<td>24.3</td>
</tr>
<tr>
<td>Bicycle path/lane</td>
<td>12.5</td>
<td>30.2</td>
<td>12.2</td>
</tr>
<tr>
<td>School roads</td>
<td>15.8</td>
<td>7.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Week</td>
<td>24.0</td>
<td>4.3</td>
<td>18.2</td>
</tr>
<tr>
<td>Week end</td>
<td>4.8</td>
<td>2.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Day (AM)</td>
<td>13.3</td>
<td>4.8</td>
<td>12.4</td>
</tr>
<tr>
<td>Day (PM)</td>
<td>15.4</td>
<td>20.0</td>
<td>28.4</td>
</tr>
<tr>
<td>Evening</td>
<td>10.6</td>
<td>6.4</td>
<td>25.8</td>
</tr>
<tr>
<td>Poor municipalities</td>
<td>3.1</td>
<td>4.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Average-rich municipalities</td>
<td>10.9</td>
<td>2.8</td>
<td>17.1</td>
</tr>
</tbody>
</table>

With regard to the thresholds (p < .001), municipality status was not significantly associated with helmet use. However, interaction terms were significant, the variable was maintained in the model. Helmet use was significantly and positively associated with female sex, younger age group, bike paths or lanes, 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).

Furthermore, since the interaction terms were significant, the effectiveness of the program had to be distinguished according to the category of municipality and the bicycle-riding circumstances. Indeed, children observed in poor municipalities and riding on local streets in the target community were 1.76 (1.10, 2.78) times more likely to be wearing a helmet than those riding on local streets in the comparison community. Regardless of riding circumstances, the program was 3 times more effective among children observed in the average-rich municipalities than in the poor ones. In average-rich municipalities, the program was effective among children observed in all bicycle-riding circumstances – i.e. local streets – 5.72 (3.53, 9.30), bike paths or lanes – 3.28 (2.13, 4.87), and school roads 3.08 (1.83, 4.95); but in poor municipalities, it was effective only among children observed on local streets – 1.76 (1.10, 2.78). Regardless of municipality category, the program was more effective among children observed on local streets than those observed on bicycle paths or lanes and school roads.
4.3 Differences in reduction of risk of head injury by sex, age, and category of municipality over time

Considering changes between periods with regard to risk of hospitalization due to head injury within the target and comparison communities, taking sex and age into account (Study 3), no remarkable changes occurred in the comparison community over time, whereas significant changes were observed in the target community. In particular, boys showed a significant decrease in risk of hospitalization after a bicycle-related head injury during both the implementation and post-implementation periods (RR = 0.74, 95% CI = 0.55, 0.99 and RR = 0.56, 95% CI = 0.40, 0.77, respectively), and girls only during the post-implementation period (RR = 0.52, 95% CI = 0.33, 0.82). Also, children from both age groups (younger – 5-8 years and older – 9-12 years) showed a significant decrease in hospitalization risk during the post-implementation period (RR = 0.46, 95% CI = 0.31, 0.68 and RR = 0.63, 95% CI = 0.44, 0.89, respectively).

Considering changes between periods with regard to risk of hospitalization due to head injury within the target and comparison communities for each category of socioeconomic status (Study 4), it was observed that children from the municipalities exposed to the program, both poor and average-rich, showed a significant decrease in the risk of hospitalization after a bicycle-related head injury during the post-implementation period (RR = 0.45, 95% CI = 0.26, 0.78 and RR = 0.55, 95% CI = 0.41, 0.75 respectively). No such difference between periods was observed in the comparison community.

4.4 Intra-group differences in reduction of head injury by sex, age and category of municipality between period

With regard to the program’s impact by observation period (Study 3), boys, girls and younger children from the target community showed a significantly higher risk of hospitalization during the period preceding implementation of the program than those from the comparison community (boys: RR = 1.59, 95% CI = 1.10, 2.29, girls: RR = 1.92, 95% CI = 1.11, 3.31, young children: RR = 2.34, 95% CI = 1.45, 3.79). For the subsequent periods (implementation and post-implementation) differences between the two groups decreased, becoming statistically non-significant for boys and for younger children. Girls from the target community, for their part, continued to show a significantly higher risk of hospitalization during the implementation period (RR = 2.05, 95% CI = 1.10, 3.80), but not during the
post-implementation period. No significant difference was found in any respect for children in the older age group living in the target community.

Furthermore, the program impacted favourably on the risk of hospitalization for head injury following a bicycle collision by observation period for each category of municipality (Study 4). During the period that preceded the implementation of the program and for each category of municipality, children from the target community showed a significantly higher risk of hospitalization than those from the comparison one for both categories of socioeconomic status (Poor: RR = 3.19, 95% CI = 1.29, 8.05, Average-rich: RR = 1.49, 95% CI = 1.07, 2.08). For the two subsequent periods (implementation and post-implementation), the difference between the two groups decreased to a statistically non-significant level.

4.5 Bicycle-related injuries other than those to the head

Using the pre-implementation period as reference and regarding other types of bicycle-related injuries, no remarkable difference between periods was observed in hospitalization risks either when considering age and sex-based comparisons (Study 3) or comparing children based on the socioeconomic status of their living area (Study 4).

Likewise, considering intra-group differences (i.e. sex, age, category of municipality) between period with regard to the risk of hospitalization for other types of injuries related to bicycle collisions, no significant difference was found between target and comparison communities.

4.6 Summary of findings

The results reveal quite favourable changes in terms of the penetration of the safety behaviour promoted by the program and of the decrease in head-injury morbidity. The Montérégie program was indeed effective in increasing children’s motivation both to own and to use a bicycle helmet, in their actual observed use of helmet while cycling and it decreased the risk of head injury substantially.

The program had an accelerating effect on ownership over time and it was the main predictor of high intention to use a bicycle helmet. The other variables considered, such as a number of psychosocial factors, improved prediction both of high intention to wear a helmet and of ownership, such as positive behavioural beliefs and favourable normative beliefs concerning helmet use. For their part, low
intention to wear a helmet and non-ownership were associated with the importance attributed to enabling factors.

Helmet use was significantly associated with age, sex and bicycle-riding circumstances. The program was effective in increasing helmet use and its effects did not differ between sexes, age groups, or different years. However, in spite of the constant progression of helmet wearing during the four years of the program, the latter did not succeed in closing the gap existing between boys and girls and between age groups. Regardless of municipality category (average-rich and poor), the program was more effective for children cycling on local streets than those cycling on bicycle paths or lanes and school roads. It was also three times more effective among children observed in the average-rich municipalities than among those in poor municipalities. It was effective for children cycling in all bicycle-riding circumstances in average-rich municipalities; in poor ones, however, it was effective only for children cycling on local streets.

The program reduced the incidence of hospitalization for bicycle-related head injuries over time among boys and girls, younger and older children as well as among children from both poor and average-rich municipalities. Finally, the program’s positive impact on the risk of head injury was maintained during the three-year period following the completion of the program.
5 DISCUSSION

5.1 Main findings

5.1.1 Attitudinal and behavioural changes

Success and time: The program was effective in increasing children’s motivation to use, as well as to own a bicycle helmet. After the program had been operating for four years, 56% of the children in the target community, compared to 36% in the comparison one reported owning a helmet. Furthermore, in line with self-reported data, observed helmet use did grow steadily and substantially in the target community. The observed helmet use rate was 1.3% before the implementation and 32.5% after the fourth year of the program.

Time proved to be the principal predictor of ownership and exposure to the program, the principal predictor of a high intention to wear a helmet and the second predictor of owning one. As ownership actually increased anyway in the comparison community, it is likely that it would have increased in the absence of a program even in Montérégie (i.e. a secular trend independent of the program came into play). Nevertheless, it can be posited that the program accelerated the adoption of this behaviour. Indeed, while the program was in place, helmet use rose from year to year and the program effectiveness was similar in 1991, 1992, and 1993.

Overall, these results corroborate those of other studies in the field. Indeed, as noted in other evaluations of bicycle helmet campaigns, ownership and helmet use do increase over time when voluntary use is promoted at the local level (Wood, 1988; DiGuiseppi, 1989; Bergaman, 1990; Moore, 1990; Morris, 1991; Côté, 1992; Parkin, 1993; Liller, 1995).

Age and sex matter: In this study, high intention to wear a helmet and helmet ownership are both associated with females and younger age. Younger age impacts on intention level and ownership together with having more positive behavioural beliefs (attitudes towards helmet) and more favourable normative beliefs (helmet is socially accepted). By contrast, low intention and non-ownership were associated above all with the importance attributed to enabling factors (law requiring helmet use, safe place to store helmet, nicer looking, anti-theft system).

In line with self-reported data and other authors’ findings (Heiman, 1987; DiGuiseppi, 1989; Parkins, 1993; Rivara, 1994; Miller, 1996), observed helmet use proved to be significantly associated with age and sex of the child and, in addition,
with bicycle-riding circumstances (see below). Moreover the observed helmet use progression was similar among younger (5-8 year olds) and among older (9-12 year olds) children and among girls and boys.

To date, there are not many studies that have focused on the psychosocial factors that influence motivation to own and use a bicycle helmet, which makes the results obtained difficult to compare. These results do indicate, nevertheless, that girls and younger children are more receptive to the prevention messages and to the activities conducted to modify children’s attitudes towards and acceptance of helmets. After the fourth year of the program, children who had low intention to use a bicycle helmet or who still did not own a helmet were more resistant and were often boys and among the oldest. This in turn suggests that behaviour change within this group is particularly difficult, perhaps because of the importance of peer pressure that may counteract program-based enforcement strategies.

One study which examined teenager’s attitudes towards helmets after the introduction of compulsory helmet wearing legislation in Australia reported that 65% of teenagers owned a helmet, but only one-third wore it the last time they rode bicycle (Finch, 1996). Fewer than 25% of respondents always wore a helmet when they rode a bicycle, despite legislation. It was also observed that major factors leading to teenagers not wanting to wear a helmet were appearance and comfort.

**Riding and living circumstances:** Generally speaking, the program proved to be effective among children observed in most bicycle-riding circumstances (local streets, bike paths or lanes, school roads) but it seemed to be more effective on local streets than on bicycle paths or lanes and school roads.

More specifically, the program turned out to be effective in all bicycle-riding circumstances among children observed in average-rich municipalities; in poor ones, however, it was effective only for those observed on local streets.

The fact that helmets are worn less on local streets among children observed in both average-rich and poor municipalities than on bicycle paths may have various explanations, one of them being the expected length of a ride and associated perceived risk. In fact, parents and children may perceive bicycle rides around their homes as safer and therefore not requiring helmet use. For instance, a study gathering the views of children living in New York revealed that a majority of boys and girls (12 and 13 years old) did not perceive a need to wear helmets for routine riding or short trips (Loubeau, 2000). Another study, conducted in Québec, also found that lack of helmet use was associated with short trips (SAAQ, 1993). This view is mirrored in other traffic-safety issues, like that of the use of safety belts in cars, where people do not perceive the risk of accidents when driving short distances and tend not to use safety belts and child restraint systems on short car rides (Wagenaar, 1988; Webb, 1988).
For its part, the fact that helmets are worn to a lesser extent on school roads may be explained by peer pressure. Previous studies suggest that poor role modelling by peers and parents or other adults may explain low helmet use rates (DiGuiseppi, 1990; Liller, 1995; Finnoff, 2001; Twomey, 2001).

The program proved to be one in three times as effective among children observed in poor municipalities as in average-rich ones. Relative effects of the kind observed with the Montérégie program have not been studied much to date, with the exception of an area-based study in Ontario (another Canadian province) also pointing to lower helmet use among children from low-income areas in the face of voluntary use (Parkin, 1993).

Yet, for those children, the program was nonetheless effective on local streets, which can be considered as a positive result given the excess risk of bicycle-related injuries in those cycling areas. It can be added that one of the particular elements of the Montérégie program was that it placed a priority on reducing bicycle-related head injuries by intensifying the intervention in bicycling areas where bicycle-related head injuries were highest (i.e., on residential streets and areas close to children’s homes (Dussault, 1991). For instance, 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 helmet, organization of bicycle events or bicycle safety days) in local neighbourhoods during the two months of summer when children were out of school.

In view of the results achieved, the question is raised as to the nature of the means used to reach children living in poverty. The implementation of various activities designed to promote helmet acquisition (discount coupons of $5 and $10, bulk buying, distribution of free helmets) in the program appeared limited in reaching the children in this group. Comments made by teachers and community workers in these low-income areas suggest that helmet cost may be a barrier to acquisition. Thus, even if discount coupons can “play a central role” in the program’s effectiveness (Rivara, 1994) they seem to be insufficient in the specific context of this study, where 21% of children were from poor families and 11% came from extremely poor families. On the other hand, the cost of the bicycle helmet does not seem to be the only explanation for the lower penetration of education programs in children from underprivileged areas. Indeed, a bike helmet subsidy program among low-income school children in Ontario, Canada showed that despite removal of economic barriers, by offering significant discounts, and despite the fact that the children purchased helmets, they still did not use them (Parkin, 1995).

Factors of success extrinsic to the program: The observed increased ownership and use of bicycle helmets found in this evaluation of the Montérégie may have both extrinsic and intrinsic explanations. There are at least three main extrinsic
factors that ought to be mentioned that may have introduced changed independent of the program: a national intervention, contamination of the comparison community and an expected secular trend. First, parallel nationwide educational campaigns promoting bicycle helmet use conducted by the Québec Automobile Insurance Board in 1993 and the Canadian Medical Association in 1992 and 1993 could have favourably influenced the predisposing factors (attitudes, beliefs, values, knowledge) with regard to bicycle helmets and thus motivated children to own and use a helmet. Yet, the impact of these programs was surely reduced because they included little financial incentive to purchase a helmet, whereas the cost of the helmet had been identified by parents as a major barrier to its purchase.

In the second place, during the last year of implementation of the program there was contamination of the comparison community, when 21% of this community, including the largest poor community, was exposed to a local, independent bicycle helmet promotion campaign; this can also explain the fact that children in average or rich municipalities in the comparative region wore helmets less than their counterparts in poor municipalities.

Finally, as mentioned earlier, a secular trend took place as helmet use increased in both the target and comparison communities, a phenomenon that can be related to the progressive expansion of what was an innovation at that time—helmets. Also, as time proved to be the principal predictor of ownership, it may be hypothesized that behavioural changes would have taken place without the program.

Factors of success intrinsic to the program: Among the factors intrinsic to the program with most determinent importance to the success of the Montérégie program in convincing children to voluntarily use a bicycle helmet when riding a bike, one can mention the theoretical foundation used to design the program, globally and in specific aspects, the identification of determinants of bicycle-helmet wearing prior to the program, the consequent choice of messages conveyed that were clearly adapted to the target community and age group, the combined use of several credible channels, the intensity of activities, the community commitment, multiple strategies to reduce helmet cost and, last but not least, the adequate duration of the program (4 years) (see also section 1.6).

5.1.2 Injury risks

Overall injury risk reduction: First, the program is associated with a significant reduction in the incidence of hospitalization for bicycle-related head injuries among children from both sexes, age groups and categories of municipality (poor and average-rich).
A decrease in head-injury risk during a period of increasing helmet use is a result consistent with reports from Canada (Schwartz, 1996; Leblanc, 2002), the USA (CDC, 1995), the UK (Cook, 2000), Australia (Vulcan, 1992; Acton, 1996), and New Zealand (Scuffham, 1997; 2000). The studies conducted to evaluate the effect of bicycle helmet-wearing programs on injury risks (Cameron, 1994; Rivara, 1994; Scuffham, 1997) have found that the head-injury rate tends to decline when bicycle-helmet wearing is promoted at the community level. As the bulk of those studies take the form of trend analyses, it is difficult to assess the extent to which our results are comparable with theirs, due to differences in materials and methods adopted. For example, the American study by Rivara et al. (1994), did not have full coverage of the population at risk and had no comparison community, but it incorporated injuries from both in-patient and out-patient registries. Also, the Australian study conducted by Cameron et al. (1994) used a definition of head injuries less inclusive than our own.

Risk reduction at different pace: The most important short-term gains were found among boys and among young children, for whom a significant risk reduction was already observable during the implementation of the program compared with the pre-implementation period. Those were the groups most at risk before the program was launched. Considering categories of municipality, gains were registered during post-implementation and were comparable between categories despite a lower adoption rate of protective target behaviour in poor municipalities.

In the target community, from pre-implementation through to the post-implementation period, the absolute gain in terms of a decrease in the number of hospitalizations due to bicycle-related head injuries was almost twice as high among boys (46 cases) as among girls (26 cases) and higher among younger children (43 cases) than among older ones (29 cases).

The finding related to boys was somewhat unexpected, given the lower penetration of the program among this group in terms of helmet-wearing. It might suggest that there are important differences in cycling habits and cycling behaviours (including where cycling takes place) between the sexes, to the detriment of boys. Such differences, in turn, would make helmet use an even stronger determinant of individual protection in the case of boys.

On the other hand, higher injury risks among younger children as compared to older ones may, above all, be attributable to the developmental differences that make younger children more prone to fall off a bicycle and more likely to injure themselves in such a fall. Also, younger children can be expected to use bicycles for play (in parks or on sidewalks), rather than for commuting, to a greater extent than their older counterparts (Rogers, 1996). As in the case of boys, helmet wearing
becomes an important determinant of individual protection among younger children.

Considering category of municipalities, the reduction in number of hospitalizations due to bicycle-related head injuries was higher among children from the average-rich municipalities (decrease in hospitalization cases for bicycle-related head injuries during the study period: average-rich 52 and poor 23 for a total number of 111,370 and, 27,450 children exposed, respectively). The relative gain, on the other hand, was just as great among children from poor and average-rich municipalities. This is somewhat surprising when taking into account the lower penetration of the program into the poor municipalities in terms of helmet wearing. It is possible that children from poor municipalities had more individual and environmental characteristics that increased their risk of head injury than those from average-rich municipalities, and that helmet use became an important gain in terms of reduction in the severity of the injuries (i.e. hospitalizations). Alternatively, cycling may have been less common among children from the municipalities characterized as poor, and, in these, more common among relatively well-off children.

Risk reduction in the after-program phase: The fact that the program’s positive impact on head-injury risk among boys and girls, among younger children and among children from both categories of municipalities was maintained during the three-year period following the completion of the program is indicative of the fact that the duration of a program is important not only for the acquisition and the retention of a safe behaviour, but also for obtaining – and even maintaining – significant results in injury-risk reduction.

The risk of bicycle-related head injury in children from the Montérégie was higher than that of the comparison community in the pre-program phase, but was no longer so during the post-program phase. Whereas the initial difference may be a reflection of a variety of circumstances disfavouring children in the target community (e.g. age at the beginning, habits and skills), and also in their physical and social environments, it seems reasonable to suppose that the attainment of comparable risk levels following the program are attributable, at least in part, to the progressive and increasing adoption of the protective behaviour promoted by the program.

Indeed, the reduction in hospitalizations might have been made possible by the maintenance of activities within the community and among the most significant agents of change, even in the absence of an official program. Helmet accessibility and affordability, the commitment of social clubs and sports associations, and decisions to make bicycle helmet wearing compulsory in some municipalities and schools are all examples of sustainability factors.
It ought to be stressed, however, that some of the differences observed between the two communities may have been somewhat overestimated due to the slight decrease in the size of the target population (2%) and the increase in that of the comparison community (7.5%). But the changes possibly attributable to this source are far too small to explain the remarkable risk reduction observable even during the program itself.

Injury risk in light of behavioural change: The increase of bicycle helmet wearing year by year over a four-year period reflects the emergence of new norms within the target community, that go hand-in-hand with a decrease in bicycle-related head injury. The use of open cohorts in the four studies evaluating this population-based intervention reinforces the idea that it is clearly a behaviour that remained in the community.

As shown in Figure 7, the combined results on bicycle-helmet ownership and head injury reduction over time strongly suggest that helmet ownership is associated with a decrease in head injury rates as is helmet wearing. The helmet ownership rate is an indicator of user rates and is an important measure to consider since one is unlikely to use a helmet if one does not own one.

![Figure 7. Trend in helmet ownership, helmet use and risk of hospitalization due to head among children – target community](image)

A further finding of importance is the benefit incurred by the groups at risk under-represented among users. When the program ended, boys, older children and children from poor areas were under-represented among voluntary helmet users. These differences in the achievement of the program by sex, age group and category of municipalities suggested possible differences in magnitude of success...
with regard to head injury by particular group of children. It could not have been otherwise since the relative gains were more significant among boys, and just as great among children from poor and average-rich municipalities for whom a significant risk reduction was already observable during the implementation period of the program, despite the lower penetration of the program among boys and into poor municipalities in terms of helmet wearing.

**Extrinsic factors of risk reduction:** A first extrinsic factor likely to explain, in part, the reduction in incidence of hospitalizations for bicycle-related head injury is a cyclical trend in the sense of overall reduction in hospital morbidity for accidental injuries between 1982 and 1996 in Québec. The rate of hospitalization for the entire population experienced a dramatic decrease since 1982 and the same phenomenon was observed for children aged 5 to 14 (Hamel, 2001).

A further extrinsic element that may have contributed to injury risk reduction is the integration of the program into a broader program on road traffic injury prevention in the intervention community, targeting all categories of road-traffic injuries in the target community (Montérégie) during the same period. The other, concurrent programs were aimed at reducing the number of hazardous locations/infrastructures (Brown, 1992) and drunk-driving, and also at improving emergency services. In particular, a number of environmental changes certainly did have a protective effect, as revealed by the reduction of injuries among pedestrians (results not presented here). Nevertheless, given that head injuries while cycling often fall into the category “single injuries” (with no other vehicle involved) rather than “collisions with motor vehicle”, it is reasonable to suppose that the increase in helmet wearing (from a rate close to zero) was the most important contributor (among all factors) to the positive impact observed.

An alternative explanation hinted at by the current debate in injury-prevention literature is risk reduction attributable to cycling reduction (i.e. reduced duration of exposure) among members of the target group (Robinson, 1996). However, the nature of the program (based on voluntary adoption) and the evidence of no decrease in cycling (from consideration of changes in other types of bicycle-related injuries) speak against this hypothesis.

In parallel with behavioural changes, nationwide educational campaigns promoting bicycle helmet use conducted by the Québec Automobile Insurance Board in 1993 and the Canadian Medical Association in 1992 and 1993 may have contributed to reduction in the risk of head injuries.
5.2 Strengths and limitations of the study

The evaluation of the Montérégie program informs about the effect obtained on attitudinal and behavioural changes, as well as about the outcome on head injury risks. The overall impression given is that of consistent favourable results in both attitudinal and behavioural changes and risk reduction. Given the concordance of those results, one is quite inclined to believe that the objectives set when the program was launched have been reached (i.e., an overall observed rate of utilization of bicycle-helmet above 20% at the end of the program).

It is now time to assess whether this is an artefact of weaknesses in the evaluation conducted or if the program and evaluation were robust enough to be reliable.

5.2.1 Program grounds and evaluation organization and process

The very design of the program rested on a theoretical model of behaviour change (PRECEDE Model) which proposes, among others, the use of multiple strategies as a prerequisite for success and this definitely contributed to the achievement of the goal set when the Montérégie program was launched (see section 1.6.1). In addition, the process evaluation methodology used, also inspired by the model, most definitely had a favourable influence on the program’s effectiveness. Furthermore, all outcomes highlighted by the model have been subject to evaluation (process evaluation, impact/behavioural change and outcome/injury) as suggested by the PRECEDE Model, which strengthens the interpretation of the program’s effectiveness.

The four evaluations of the program forming this thesis rest on strong study designs where what is happening in a comparison community, the same one in all cases (part of it in Study 1), is taken into account so as to assess what would – or could – have happened in Montérégie over time, in the absence of a program. The comparison community was carefully selected based on criteria of similarities with the intervention community (e.g., age structure, proportion of population below the low-income threshold), and this made it possible to estimate the independent effects of the program, time, or of other extrinsic factors.

In addition, in Study 2 a quasi-experimental design with repeated measures and non-random control groups allowed for the introduction of interaction terms in multiple logistic regressions model (not conducted in other studies to which we had access) and, thereby, for the assessment of effectiveness from year to year, among different categories of children, and in different cycling circumstances. The logistic regression used in Studies 1 and 2 was considered to be a valid approach to quantify the effect of potentially confounding variables.
For their part, differences in risk of bicycle-related head injuries (Studies 3 and 4) were measured using rates ratios allowing for comparisons in time, as opposed to odds ratios. However, as the study lacks precise denominators for the pre-implementation and implementation periods of the program, over-estimations are possible. These, however, are not expected to be any great size. In general terms, changes in size of the populations of the target and comparison communities suggest that the protective effect of the program was underestimated. In any case, since the observed reduction in the population in the Montérégie was relatively small (2%), the differences in risk levels found between periods and categories of municipalities are likely to be reliable. But we do not know if the population varied equally in the two categories of municipalities.

5.2.2 Some measures of exposure

*Exposure to bicycling:* Since measure of exposure to bicycling was unavailable in Québec, the incidence rates of hospitalization were calculated on the total population, leading to an underestimation of the real incidence. Another problem brought about by the absence of a measure to exposure is the difficulty in isolating the part of the reduction in head injuries that would be attributable to a decrease in the practice of cycling resulting from being “forced” to use a helmet. But studies on the subject yield conflicting results. A time series study in Victoria, Australia reported such a reduction in cycling after the introduction of mandatory helmet use (Robinson, 1996). Another similar study, conducted in one health district in Canada closer to the area of intervention found no reduction in cycling post legislation (Macpherson, 2001). Nevertheless, no study has shown such results in the case of the education program targeting voluntary adoption of the helmet.

In the absence of direct exposure measures, the use of non-head injury as a proxy measure, as employed in similar studies (Vulcan, 1992; Cameron, 1994; Rivara, 1994; Macpherson, 2002), allows for controlling for a potential reduction in bicycling. In Studies 3 and 4, considering no significant changes in others types of bicycle related injuries, the reduced levels of risk of bicycle related head injury of children in Montérégie could scarcely be the result of diminished bicycle use in the target group.

*Socioeconomic status:* One single area-level indicator of socioeconomic position has been used in Study 2 and Study 4, i.e., the “Poverty Area” from Haan et al. (1987). The underlying hypothesis was that children from different socioeconomic positions may not be reached to the same extent by the program messages, leading to a differential penetration of the program with varying socioeconomic positions. In Study 2 (study at individual level), the area-level indicator, stratified in two categories, was used as a proxy for individual living circumstances. The data
collection strategy (direct observation without communication with the children) did not allow for individual-based data. As is the case for proxy measures, its reliability is necessarily limited. In the particular case of this study, two problems could be encountered. A first one was that all children residing in one category of community may not share the same “average” characteristic of the community. A second one is that the children observed while cycling in a given community may actually come from another community, and from another socioeconomic position.

In Study 4 (ecological study), the indicator was used at the area level. Though strongly recommended (Haan, 1987; Cubbin, 2002), the indicator does not provide a synthesis of the social and physical environmental contexts to which children from different living areas are exposed. Data of that kind, when available, would definitely be interesting to consider in further studies, to introduce some nuances into the current results. For that purpose, the recent development of a deprivation index in Québec (Pampalon, 2000) that can be used with administrative files (such as MedEcho) and may introduce the socioeconomic status of trauma victims and enable us to improve future studies.

Moreover, in further studies, one could strive for considering areas of smaller size. As a representation of living area, a parish may be a larger and more heterogeneous population than a neighbourhood. This would result in non-differential misclassification, biasing relative risk towards unity.

5.2.3 Outcome measures

*Intention to wear a helmet, ownership and helmet use:* In Study 1, based on self-reports of intention to wear a helmet and to own one, a social desirability bias, a self-report bias and a test-retest bias (i.e. about 1/3 for the student survey in the two collections) were all possible. In addition, the validity of proxy indicators of helmet wearing (i.e., intention to wear a helmet and helmet ownership are a necessary, but not sufficient, condition for use) related to prevented bicycle-related head injuries was unknown. However, in this study these weaknesses were diminished by a great validity of sampling frame, good data collection (instrument, response rate, quality control of data collection), a robust study design with comparison community, repeated measures, large sample size and a high response rate.

Considering helmet wearing, the observation surveys conducted (Study 2) were definitely more accurate, since recall or social desirability bias was not present: the ownership rate reported by children was 56% while the observed rate of utilization was only 32% at the end of the program. Indeed, an estimate of prevented head injuries can be calculated from the change in helmet use, once the etiologic fraction is know (CDC, 1998). There are some drawbacks to these kinds of studies. In
particular, they are not accurate in identifying and classifying demographic and other personal characteristics of riders (misclassification), the difficulty in selecting an unbiased sample of sites to observe riders and resources needed and logistical problems associated with conducting observations. An observed rider may use a helmet only intermittently, so a single observation may not accurately reflect habitual use.

In the observation-based study, to avoid some of these problems, the observers received an adapted training before the data collection and an efficient community-sampling frame was developed so as to cover areas where children usually ride bikes, including specific school areas, residential and commercial streets, parks and bike path and lane. For that purpose, community informants who participated to the implementation of the program – such as police officers, members of the local social clubs and municipal leisure departments, school principals and the various stakeholders involved in cycling events – were asked in advance to identify sites where children commonly ride.

Further, the type of observation method chosen, that is migratory observation where observers were posted at fixed sites for short periods and migrated periodically to the next predetermined fixed site, attempted to combine the best features of mobile and stationary methods. In addition, as for survey data, a robust study design with comparison community, repeated measures (pre and post), and a large number of children’s observations strengthen the results of the study.

**Injury rates:** The definition of "head injury" retained for Studies 3 and 4 was deemed to be the most appropriate since it considered all the parts of the head for which a helmet offers protection. Because it has been established that helmets are effective in reducing severity of head injury, mortality or hospitalization for bicycle-related injuries are appropriate outcome measures. However, as bicycle-related mortality was low in the communities concerned during the study period 1988-1996 (about two per year), the severity criteria retained was that of hospitalization.

The hospital discharge summary data were available and easily obtained from MedEcho for the years 1988 to 1996. Moreover, serious injuries in children requiring only care in hospital E.R.s (i.e., outpatient data) are not recorded in a systematic and uniform enough manner to allow for analysis at the provincial and regional level. In fact, only three hospitals in Québec have an emergency room-based surveillance system named Canadian Hospitals Injury, reporting and Prevention Program (Laboratory Centre for Disease Control, 1991).

The registry data used for the study consisted in a standardized provincial government in-patient registry that offers full coverage of hospitals in Québec. Missing cases due to lack of information regarding external cause of injury code (E-code) have been estimated as few: 6% of all cases of hospitalization for trauma codes 800-989 (Hamel, 2001). The intervention and comparison communities
showed a similar underreporting. Since the provincial health insurance program is universal, i.e. free and accessible to everyone, it is reasonable to think that children will be seen in a hospital for serious injuries, regardless of their living conditions. Data were aggregated by three-year periods covering pre-implementation, implementation and post implementation of the program, to achieve adequate numbers for analysis.

5.3 General implications on the condition of success of the program

5.3.1 Overall assets of the program

A review of eleven community-based programs aimed at increasing the use of bicycle helmets by children and adolescents identified the elements common to the programs that contributed to their success (Klassen, 2000). These elements include the use of multiple strategies targeted at different audiences to address three pivotal barriers to helmet use: lack of awareness about the risks of bicycling and the effectiveness of helmets, the cost of helmets, and the perception of negative peer pressure regarding helmet use. The population-based program developed in Montérégie could meet these requirements for success.

To date, few programs encouraging helmet wearing have clearly identified the use of the health promotion model. However, in the field of injury control and safety promotion for behavioural changes, several interventions aim to change risky behaviour to prevent injuries. Geller et al. (1990) addressed issues and research needs in the domain of behaviour modification for injury control and suggested that models of behaviour or frameworks can be used to understand and predict health-related behaviour and help in developing and evaluating interventions for injury control.

The population-based program developed in the Montérégie did impact favourably on the voluntary adoption of safety behaviour and injury-risk. Again, its success is surely attributable to respect throughout the process of development and implementation of the program, of the different steps suggested by the model retained (PRECEDE). In addition, a first study had been conducted to identify the health problem, the risk factors, the population at risk (in this case, head injuries related to lack of helmet use among children 5-12 years old) as well as the initial behaviour within the population targeted (helmet use rate 1.3%) (Brown, 1989). This corresponds to the following steps in the model: health problem, behaviour and lifestyle, environment (Green, 1991).
In the case of the predisposing, reinforcing and enabling factors, a preliminary study, according to the Theory of Reasoned Action, identified the factors that were most likely to influence children’s intentions to use bicycle helmets, and inspired the advocacy messages adopted during the program (Otis, 1992). In addition, a telephone survey was conducted with the parents of the children targeted in order to find out the barriers to purchasing a helmet (Lesage, 1989).

Since it had to do with an innovative behaviour within the community, following Roger’s theory, the promotion of bicycle helmet use was adjusted to the socioeconomic circumstances and characteristics of the eventual adopters. In this sense, a set of activities dealing with the product (availability of small helmets inexistent before the program, reduction of the purchase price through a variety of means, free distribution of a large number of helmets) were introduced and persuasive communication was chosen to make parents and children aware of the program. As for implementation of the program, the social action model allowed for mobilization of the entire region for the four years of the program. Finally, the results of the annual evaluations of the process (Figure 2) highlight the number and intensity of the activities conducted.

5.3.2 Additional considerations for prevention

It is valid to think that long-lasting programs based on models of behaviour or frameworks using multiple strategies are effective to substantially increase adoption of a voluntary and innovative behaviour (here, bicycle helmets) among a population of children aged 5 to 12. Moreover, these programs significantly reduced the risk of bicycle-related head injury with a similar magnitude of success with regard to head injury by particular group of children (boys, children from poor municipalities who were under-represented among helmeted children). This suggests that such programs have a great impact on reducing bicycle-related head injuries, partly because they embrace the groups most at risk and in particular because they have potential to benefit children from less accessible groups, without stigmatizing them unduly or threatening their autonomy.

The results of the evaluation enabled decision-makers to introduce new orientations vis à vis underprivileged communities. Starting in 1996, new funds were allocated in order to identify a strategy that would result in greater contact with children from underprivileged sectors. Then in 1997, the activities from the “My bicycle helmet is “In”” program were enhanced for children enrolled in the schools in underprivileged areas and community organizations were involved in enabling the application of a subsidized program for the acquisition of helmets at reduced costs.
Lastly, the fact that this type of program presents certain limits to motivate boys and the oldest children to wear a bicycle helmet raises certain thoughts concerning the choice of measures to propose to reduce head injuries related to bicycle accidents. In fact, even the introduction of a law requiring helmet wearing, preceded by a long period of promotion of voluntary behaviour did not succeed in motivating teenagers who owned a helmet to wear it (Finch, 1996). This suggests that the law requiring helmet wearing is not an end in itself. In addition, as for the prevention of injuries in general, the introduction of measures modifying environments must also be envisioned.
6 CONCLUSION

The results of the studies forming this thesis suggest strongly that the Montérégie program did succeed in increasing bicycle helmet use and, consequently, in reducing the risk of bicycle-related head injuries leading to hospitalization. This was achieved through a series of activities targeting the whole population and aiming at voluntary bicycle helmet use through the modification of psychosocial factors associated with children’s helmet ownership and use.

The program’s success is reflected in self-report data showing that exposure to the program is the principal predictor of children’s high intention to use a bicycle helmet. That exposure has had an accelerating effect on the process of voluntary adoption of this behaviour that would have taken place anyway, given the cyclical trend observed.

Bicycle helmet wearing increased at a comparable pace over the years in both sexes and age groups, indicating a modification of children’s behavioural and normative beliefs towards bicycle helmets. Nevertheless, girls and young children were definitely more receptive to the messages carried by the program.

In addition, observed helmet use when riding, though on the increase in all riding sites during the program, proved to be dependent on bicycle-riding circumstances, the program being somewhat more effective, globally, on local streets than on bicycle paths or lanes and school roads. As such, this can be regarded as a very satisfactory result as local streets are the site where bicycle-related head injuries were more likely to occur in the target community.

A further result on helmet wearing, of greater concern, is that of the program being one in three times less effective among children observed in the poorer municipalities in spite of the various activities designed to reduce economic barriers. Yet, in those areas, positive results were achieved in more at risk areas, i.e. on local streets.

As a whole, the program is associated with a significant reduction in the rate of hospitalization for bicycle-related head injuries in the target municipality and it benefited children from both sexes, age groups and categories of municipality. Surprisingly – and satisfactorily – in spite of the lower penetration of the program among boys and children from poor municipalities, considerable relative gains in reduction of injury risks were observed in those groups.

The maintenance of the program’s positive impact on head injury risk reduction during the three-year period following its completion indicates that the target behaviour might have been maintained in the community. Possibly, the very
duration of the program has been an important element for the sustainability of its main message: “Bicycle helmets are ‘In’”.

There are good reasons to believe that the program in itself is responsible for a large share of those favourable results. Among other assets, it was based on multiple strategies consistent with underlying theory of behavioural change and planning framework and it included a wide variety of activities undertaken every year during the program and targeted towards determinant stakeholders. The process was followed-up closely. It is of course plausible that a number of factors extrinsic to the program contributed to either behavioural changes or risk reduction.

From another point of view, it appears that population-based programs have the potential to benefit children from less accessible groups. They have the advantage of avoiding undue stigmatizing and threat to their autonomy.

Programs such as that from the Montérégie cannot be regarded as substitutes for legislation in terms of impact, but they can definitely serve as a fruitful complement – if not necessary prerequisite – to them.
ACKNOWLEDGEMENTS

This was a large-scale project, which germinated in 1998. Without the help and encouragement of many people, it would most definitely have been difficult to bring to conclusion.

I would especially like to thank my supervisor, Lucie Laflamme, who guided me throughout this project with her prudent advice and her rigorous demands in a process that proved fruitful. Her experience and her knowledge in the field of research were invaluable to me. Aside from her limitless availability, I was so fortunate to enjoy her constant enthusiasm and her kindness. I hope that she will derive a certain satisfaction in rereading the results of my work.

The material that served to accomplish part of this thesis comes from research that I conducted at the Montérégie Department of Public Health. I would like to express sincere gratitude to the members of the injury prevention team for their support in the implementation of the "Bicycle Helmets are 'In'" program, and I would like to thank Diane Sergerie and Ruth Pilote for their constant support as well as their friendship.

Another part of this thesis required access to databanks on hospitalizations. I would thus like to thank the Laval and Laurentians Departments of Public Health, as well as Josée Payette from the Montérégie for their availability in providing MedEcho data for their region and for thus enabling me to produce the study of impact on injuries.

I would like to thank Lise Gauvin from the department of social and preventive medicine at the Université de Montréal who generously provided me an helpful guidance to prepare my half time seminar.

I also greatly appreciated the student life at the Karolinska Institutet, with special thanks for the discussions that I was able to have with Marjan Vaez, Stephanie Burrows and Karin Engström. I thank them for these valuable exchanges. Moreover, the statistical support for my research provided by Marjan Vaez stands as solid evidence of this solidarity and I would like to thank her for that.

I would also like to thank Hélène Kaufman for the translation of some passages in this thesis and for revision of the English version of it and Leila Relander for preparing the final manuscript.

Finally, a huge thank you to my husband, Pierre, to my daughters, Maude and Camille, as well as to my entire family for encouraging me to persevere in this career project.
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