

# Bicycle Helmet Use in British Columbia:

## Effects of the Helmet Use Law



Robert D. Foss<sup>1</sup>  
Douglas J. Beirness<sup>2</sup>

<sup>1</sup> University of North Carolina  
Highway Safety Research Center  
730 Airport Road  
Chapel Hill, NC 27599-3430

<sup>2</sup> Traffic Injury Research  
171 Nepean Street  
Suite 200  
Ottawa, Ontario K2P 0B4



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Pre- and Post-law Bicycle Helmet Use in British Columbia

## **BACKGROUND**

Bicycling is a popular activity in British Columbia. Partly because of the moderate climate where much of the population lives, bicycling is both a common recreational activity and a mode of transportation for many individuals. Unfortunately, each year a number of bicyclists are killed in collisions and many more are injured. In the 10-year period ending in 1995, 137 bicyclists died in B.C. In 1997, 872 persons were injured in bicycle collisions with motor vehicles. Injuries are most common among two age groups of cyclists: those aged 6 through 15 and those 21 to 40 years of age (ICBC, 1998).

A large majority of bicycling deaths and disabling injuries result from head injury. About 75% of all bicyclist fatalities, and two-thirds of hospital admissions for bicycling injury involve head trauma (Rivara et al., 1998). Accordingly, the development of effective bicycle helmets, followed by promotion of their routine correct use, has long been a priority in the injury prevention community. Approximately 90% of bicyclists who die from head injuries are injured in a collision with a motor vehicle (MMWR, 1995). The large majority of less serious injuries, including 75% of non-fatal head injuries, occur in crashes (or 'falls') that do not involve a motor vehicle.

A number of studies indicate that properly worn bicycle helmets are highly effective in preventing, or reducing the seriousness of, head injury. For example, in a study of bicyclists seen in Seattle area emergency departments, Thompson et al. (1996) found that any head injury, and serious head injury, were substantially less common among bicyclists who had been wearing a helmet. A British study (Maimaris et al., 1994) found a highly similar protective effect for helmet wearers. A study of Australian bicyclists seen in Melbourne area hospitals also reported that helmet wearers were substantially less likely to experience either head or facial injury (McDermott et al., 1994). In an overview of studies that have examined helmet effectiveness, Rivara et al. (1998) report that helmets reduce the risk of head or brain injury by at least 70 percent and injury to the upper or mid-face by 65%.

Of the nearly 2000 British Columbia bicyclists injured in a collision with a motor vehicle in 1995, 25.8% were wearing a helmet at the time. This is a great deal lower

than the rate of seat belt use in British Columbia, even though helmets are similar to seatbelts in protecting against serious or fatal injury if used.

### **The British Columbia Bicycle Helmet Law**

To address the problem of low helmet wearing rates among bicyclists, in 1996 British Columbia became the first Canadian province to enact a law mandating helmet use by bicyclists of all ages when riding on a public roadway. This followed the example of efforts to reduce head injuries through transportation policy in Australia and New Zealand. Since 1994 all states and territories in both those countries have required bicycle helmet use by riders of any age. Although no U.S. state mandates helmet use for all riders, at least 20 communities (in eight different states) mandate helmet use for riders regardless of age.

Helmet use laws, especially those covering riders of all ages, have proved to be effective in increasing the rate of helmet wearing (Puder et al., 1999). In the Australian state of Victoria, helmet use jumped dramatically immediately following implementation of the helmet use law, from around 30% to 75%; the number of head injuries among bicyclists declined dramatically (Cameron et al., 1994). Evaluation of the helmet law in the state of South Australia (Marshall & White, 1994) found results similar to those in Victoria. Following introduction of a helmet law in July 1991, helmet use increased significantly and hospital admissions due to bicycling injuries decreased by about 12% a year during the first two years after the law was introduced. In New Zealand, helmet use increased dramatically, especially among children, and the number of serious injuries decreased among school-age children following enactment of a comprehensive helmet law (Scuffham & Langley, 1995).

### **Pre-law Helmet Use in British Columbia**

During the summer of 1995, Foss, Beirness & Wilson (1996) conducted a population-based survey of helmet use in British Columbia. Seventeen communities, and observation sites within those communities, were selected using probability sampling to obtain a valid estimate of helmet use among three relatively distinct bicycling populations: commuters, recreational cyclists, and children.

Observations were made at 36 locations where mainly commuters were expected to be seen, 38 locations along recreation/bike paths, mainly in public parks; and in 42 neighborhoods defined by school catchment area boundaries. In total then, bicyclists were observed in 116 separate locations throughout the province. In addition, general community observations were conducted in 16 of the 17 sampled communities.

Correct helmet use was substantially higher among persons observed on urban/commuter routes. Whereas nearly 50% of commuter route cyclists were wearing a bicycle helmet properly, only 32% of those observed riding in neighborhoods defined by school boundaries were wearing a helmet. At recreational sites nearly 34% of cyclists were wearing a helmet correctly. Helmet use in the general community population observed through rolling observation was lower (and misuse was higher) than among any of the specialized populations. Only 22% of persons observed in these areas were wearing a helmet properly. Another 10.7% were wearing a helmet, but in such a fashion that it would not provide the full degree of protection available in the event of a crash.

In addition to variation across different types of cycling locations, helmet use was also found to be higher in urban areas (42%) and among riders of road (i.e., 'racing') bicycles (49%). Correct helmet use did not vary substantially by age, ranging from 35% for bicyclists judged to be older than 50, to 42% by those ages 31 through 50. Misuse (e.g., loose chinstrap, exposed forehead, non-approved helmet) was more common among females and was more than three times as likely among children younger than six.

## **Post-law Helmet Use Survey**

During the summer of 1999 the same observation locations in 12 of the previously studied communities<sup>1</sup> were re-visited at the same time of day and week to determine whether helmet use (and misuse) had changed subsequent to enactment of the helmet law. Although it would have been of some interest to obtain data on helmet use during the period shortly after the law took effect, funding was not available to do so at that time. There is, however, a benefit to examining helmet use during the third year of the law. Most interventions to change human behavior, including programs and legislation, produce an initial effect that inevitably erodes over time. By examining helmet use more than two years after the law took effect, this study was able to document what is likely to be the stable, long-term result of the law rather than a temporary effect.

## **METHOD**

The same procedures used for the original 1995 survey were used in the follow-up survey in 1999. Those are briefly described below.

### **Sampling Communities**

Communities, defined as Cities, Towns, or District Municipalities by Statistics British Columbia, were used as primary sampling units. All communities with a projected 1994 population of 10,000 or more were eligible for sampling. Smaller communities were judged to have insufficient concentrations of bicyclists to allow efficient data collection. Statistical sampling procedures were used to ensure that a representative sample of British Columbia bicyclists would be observed. Details of this approach are described elsewhere (Foss & Beirness, 1995).

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<sup>1</sup> In the interest of cost-efficiency, the five smallest communities were excluded from the 1999 survey since they provided a relatively small proportion of observations in the 1995 survey.

## **Cycling Sub-populations**

Traditionally, bicycling populations have been identified primarily by age group. In the present research we defined other sub-populations as well. Rather than focusing only on age groups, we examined types of cycling locations in an attempt to capture different subsets of the bicycling population. This allows us to discriminate a little more finely, much as work in the area of seat belt use finds that belt use is routinely higher on interstate highways, independent of age, sex, or other factors that are generally related to belt use (Foss, Spencer & Tolbert, 1992).

*Commuter* sites were defined as locations along major roadways that would likely be used by individuals riding to and from work. In some of the larger cities there were clearly defined commuter routes. These were often identified on bicycling maps of the area. In smaller communities commuting by bicycle, in the sense that the bike is used as a mode of transportation to work, appears to occur relatively infrequently (although the proportion of workers who commute by bicycle may be the same or greater as in more urbanized areas). Data for commuter locations were collected during the morning and evening hours when commuting was most likely (7-9 am; 4-6 pm).

*Recreational* sites were defined as bike paths, recreation paths, or roadways within what clearly were recreation areas (e.g., parks). Observations were conducted at recreational sites in the late afternoon/early evening hours or on weekends.

*Neighborhood* sites were included in an effort to increase the number of children observed. These were defined as the 'catchment' or service areas of elementary schools. To collect data at these sites, rather than waiting for bicyclists to pass a fixed location, observers canvassed the area looking for cyclists – doing 'rolling' observations. This was done by systematically driving every street in the area and recording information for all cyclists spotted (including adults). Data were recorded using audiotape recorders and transcribed later to observation forms. Observations were conducted in neighborhoods in the late afternoon/early evening hours or on weekends.

In addition to the sites identified above, we also conducted rolling community observations within each of the sampled communities. By segmenting the bicycling population into purely recreational and mainly commuting sites, we believe a substantial segment of the adult bicycling population may have been excluded from observation. Thus, this sample was added to the initial study design. The procedures developed for conducting rolling observations at the school-based sites were modified slightly to accommodate rolling observations throughout the cities and towns sampled for the study.

**Observer Training.** A day-long observer training session was conducted immediately prior to the beginning of data collection. Training included a detailed explanation of data collection procedures, making accurate judgments, and locating the observation sites, as well as supervised practice doing both fixed and 'rolling' observations. All observers were joined by a supervisor at their first two assigned observation locations to ensure accuracy of observations and adherence to correct procedures..

**Data Collected.** An attempt was made to observe and record bicycle helmet use (and misuse), sex and estimated age of rider, bicycle type (mountain, road, other), use of special cycling clothing (gloves and cycling pants), and use of a back pack or bicycle pack. Day of week, time of day, site type, location, and weather conditions were also recorded at each observation site.

Helmet misuse was defined to include an unbuckled or very loose chinstrap or having the helmet tipped backward on the head to the extent that the forehead was clearly unprotected. It was often not possible to observe chinstrap tightness directly, although a tipped helmet is a likely indicator of poor chinstrap adjustment. Use of helmets other than approved bicycle helmets was also recorded as misuse.

**Procedure.** Observers visited each observation site (or neighborhood) twice at preselected times for 30 minutes on each occasion. The same observation sites where data were collected in 1995 were revisited at the same time of day and week in 1999. To avoid any possible bias in sampling, every cyclist passing the observers' location (or which the observer passed, in the neighborhoods) was to be observed. In situations where the number of bicyclists to be observed was large

(e.g., at a busy recreation site), data were recorded first on helmet use, then on all other items of interest, with priority given to sex, age, and bicycle type. This procedure maximized the number of observations for the primary item of interest – helmet use.

## RESULTS

### Sample Characteristics

In both 1995 and 1999, data were collected during July and August in 12 communities.<sup>2</sup> At these sites 3,950 bicyclists were observed in 1995 and 4,246 in 1999 for a total of 8,196. Figure 1 shows the distributions of sample characteristics for the two years. There is one noteworthy difference between the two years. In 1999, 35% of observed cyclists were judged to be between the ages of 16 and 30,

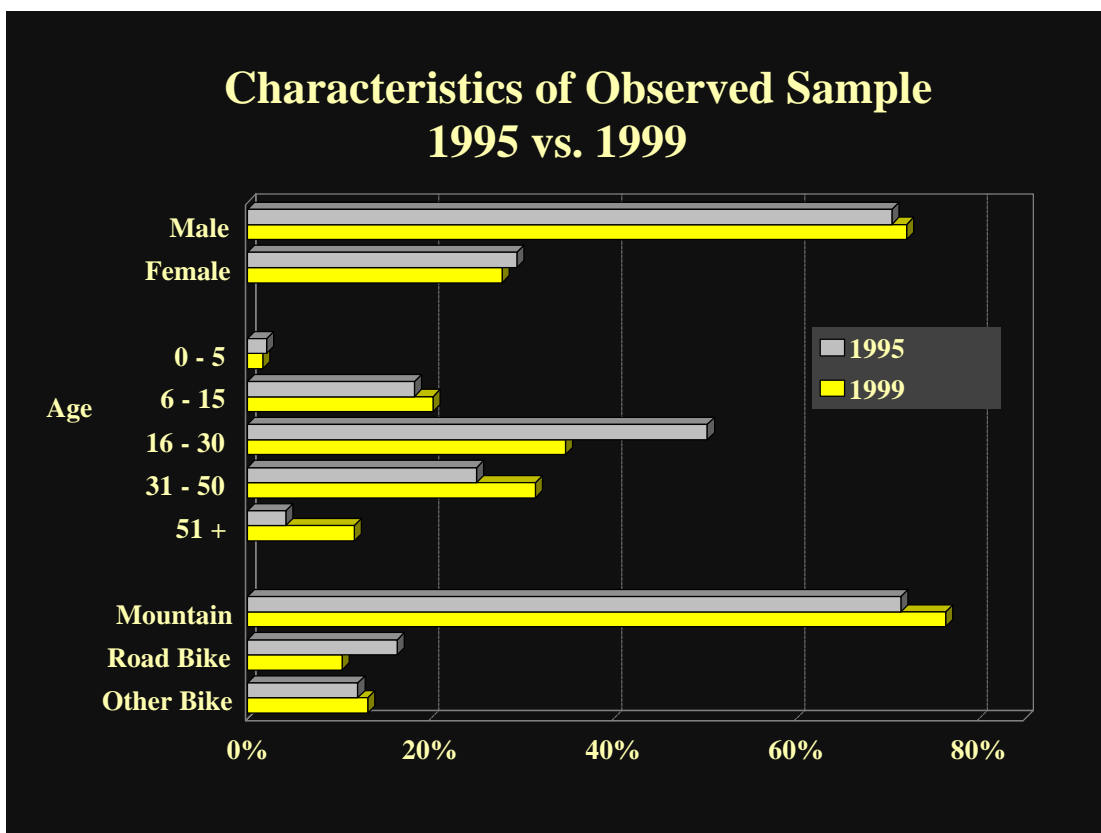


Figure 1

<sup>2</sup> Abbotsford, Burnaby, Chilliwack, Coquitlam, Kelowna, Port Coquitlam, Prince George, Richmond, Saanich, Surrey, Vancouver, and Victoria.

whereas 50% were judged to be of this age in 1995. It is not clear why this difference occurred. It is possible that the cycling population has changed, but it may also be that these differences reflect the fairly subjective nature of judging age for a person seen briefly while riding by, often from a distance. This difference is not of great concern for the purposes of this report because helmet use among the three oldest age groups where judging age is most difficult was very similar. Because helmet use varied substantially by site type in 1995, data for the following analyses were weighted to account for differences in the number of cyclists observed at the different types of sites.

### Helmet Use Among Different Cycling Populations

In all of the following, reported helmet use includes both correct and incorrect use unless otherwise specified. As Figure 2 shows, helmet use increased among cyclists at all types of locations. Among cyclists observed on commuter routes, helmet use was 60% in 1995. That had increased to 75% by 1999. Helmet use

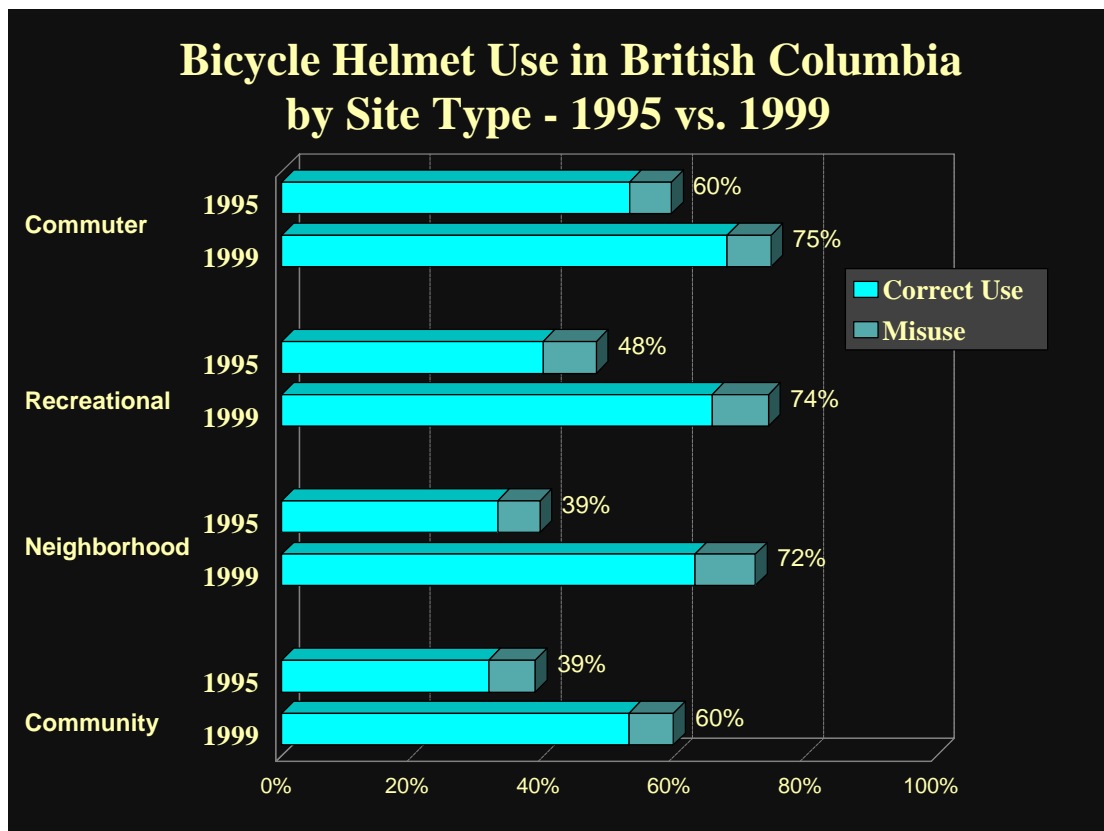


Figure 2

among cyclists at recreational locations increased to a greater degree, from 48% to 74%. In 1995 helmet use was much lower among riders observed in neighborhoods (39%), but that had increased to 72% in 1999. Finally, in the more general community sample, helmet use increased from 39% to 60%. Rates of helmet misuse were nearly identical among riders observed at the various types of observation sites.

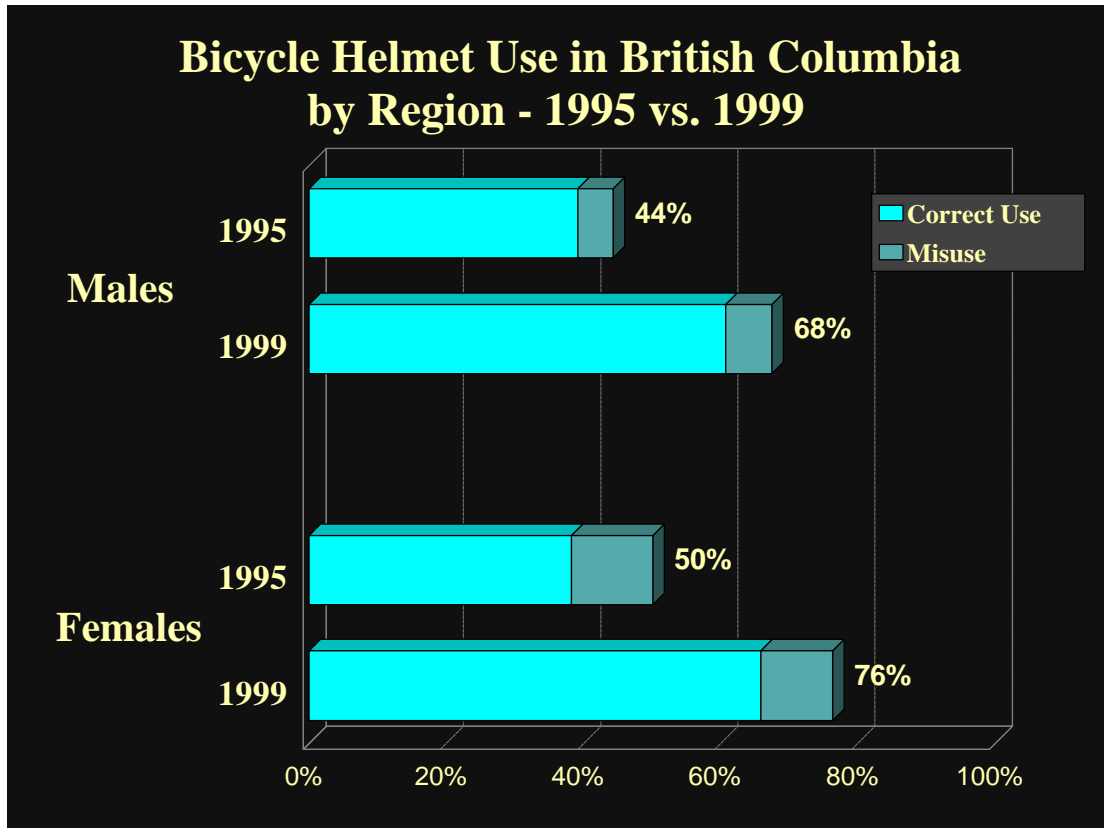


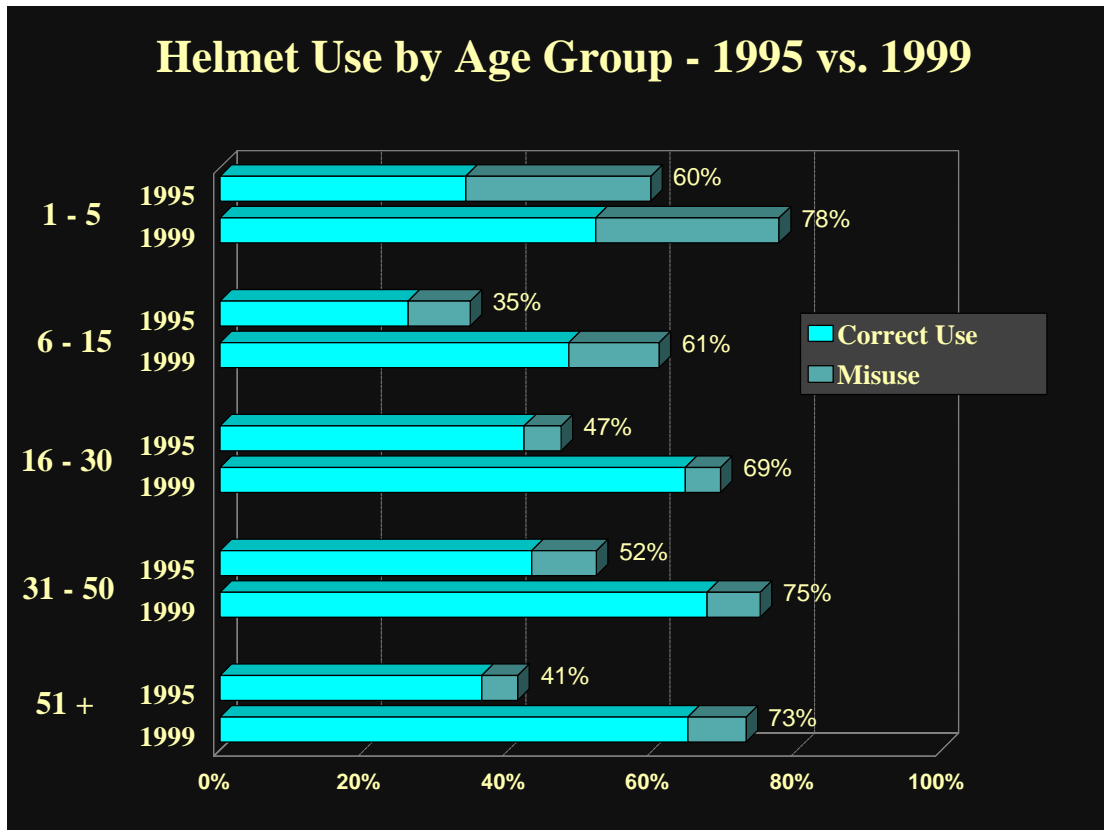
Figure 3

### Helmet Use According to Sex

In 1995 although females were somewhat more likely to wear a helmet (56% vs. 50%), correct use was virtually identical among males (39%) and females (38%). By 1999, the difference in both use (males 68%, females 76%) and correct use (males 61%, females 66%) had increased to the point that it was statistically significant (see Figure 3).

### Helmet Use by Age of Bicyclist

Figure 4 shows helmet use rates among the various age groups. It is important to bear in mind that age was judged rather than measured, so these are approximate age ranges. Nonetheless, if age is related to helmet use, it is possible to detect a



**Figure 4**

pattern using such categories, since classification errors will exist only at the boundaries of age groups. For example, although a 5 year-old rider may be mistakenly judged to be in the 6-15 age group, it is unlikely that a 3 year-old would be misclassified. Similarly, whereas a 17 year-old might have been judged to be in the 6-15 group, he would not have been misclassified as 31-50, nor would a 25 year-old have been miscoded as 6-15.

It is clear that helmet use does vary meaningfully by age. In 1995 and again in 1999, the age group (6 - 15 years) that might be called “school age,” was the least likely to be wearing a helmet. It is also noteworthy that helmet misuse was greater among children; it was dramatic among the youngest age group (helmet misuse is

discussed in more detail below). Despite these age differences, helmet use increased to a similar degree among all age groups except for the oldest, where use increased somewhat more.

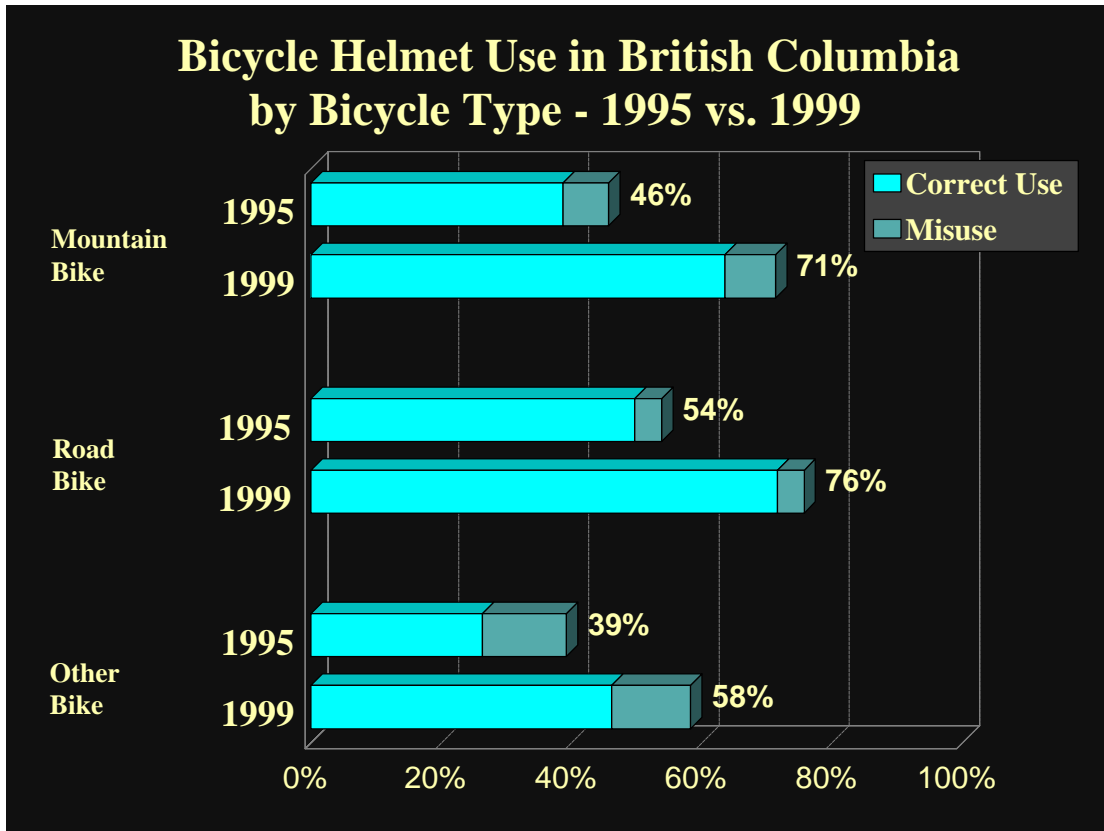


Figure 5

### Helmet Use According to Type of Bicycle Ridden

Helmet use varies by type of bicycle the rider was using when observed (see Figure 5). It appears that type of bicycle is, to some degree, an indication of the type of bicyclist. Those riding road bikes are commonly serious cyclists, often on training rides and fully decked out in cycling gear, wearing specialized cycling shorts and gloves. In contrast, those riding 'other' types of bikes appear to be the most casual of cyclists. Differences in helmet use (and misuse) are consistent with this notion. Whereas those riding road bikes are the most likely to be wearing a helmet both in 1995 and again in 1999, those on 'other' bikes were least likely to have a helmet.

The

large majority of children in the youngest age group were riding 'other' bikes, and to a small degree the lower helmet wearing rate among this type of bicycle rider reflects that. However, young children were only a small proportion of this group

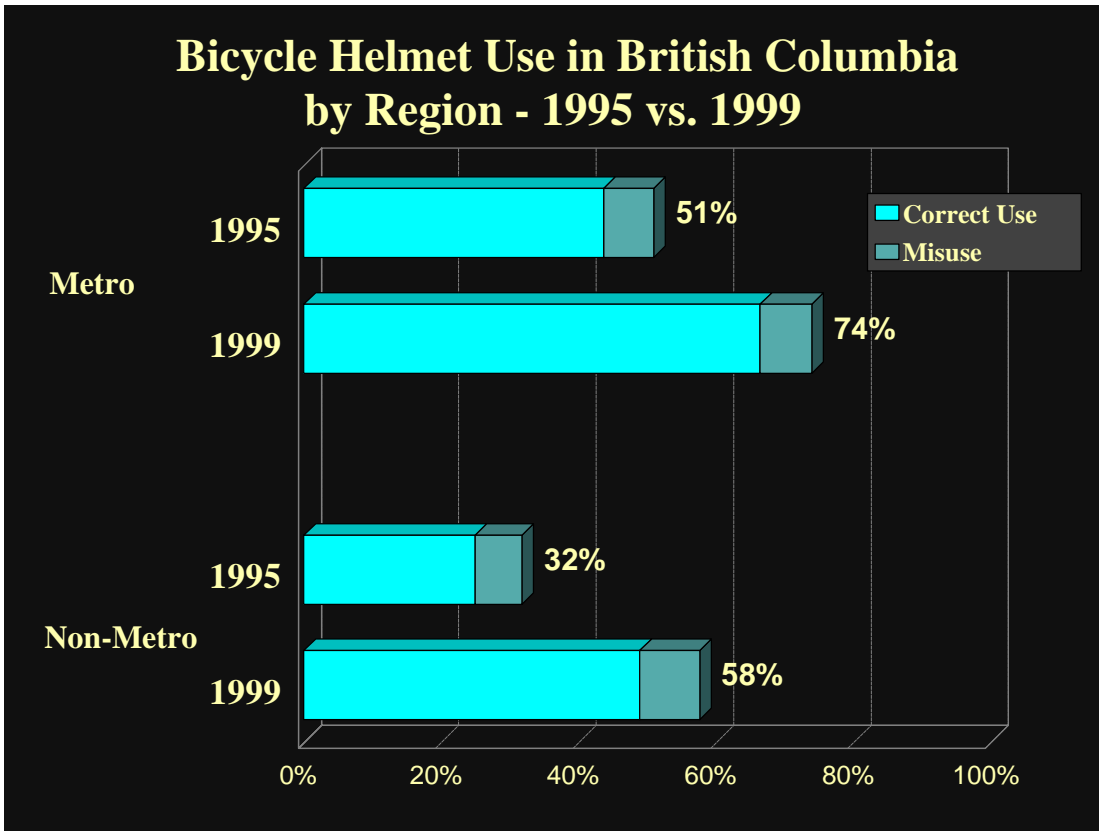


Figure 6

(14% in 1995, 9% in 1999) and when they are removed from the analysis, the pattern of use across bike type remains the same. Excluding the youngest age group, correct use in 1999 among riders of 'other' bikes remains at 46%, but incorrect use declines from 12% to 10%.

### Helmet Use in Metropolitan vs. Non-metropolitan Communities

Figure 6 shows helmet use among riders in metropolitan areas (Lower Mainland and Capital Regional District) in comparison with those observed in non-metropolitan areas. As was the case in 1995, helmet use remained higher in metropolitan areas in 1999. Although use by riders in both metropolitan and non-

metropolitan regions increased significantly from 1995 to 1999, helmet use remained significantly higher among bicyclists in the Vancouver/Victoria metropolitan areas.

### Helmet Misuse

Although helmet use has been reported above as a percentage of all cyclists observed, that is somewhat misleading. Since one cannot misuse a helmet if no helmet is worn, it makes more sense to look at misuse as a proportion of all helmets worn. When examined this way it is starkly clear that helmet misuse is a substantial problem among younger bicyclists (see Figure 7). It is encouraging that misuse has declined in all age groups since the helmet law was enacted, but misuse remains quite high among children. Although the rate of misuse is higher among the youngest age group, the degree of misuse among those generally between the ages of 6 -15 is of greater concern. Those in this age group do more riding, do so in more dangerous

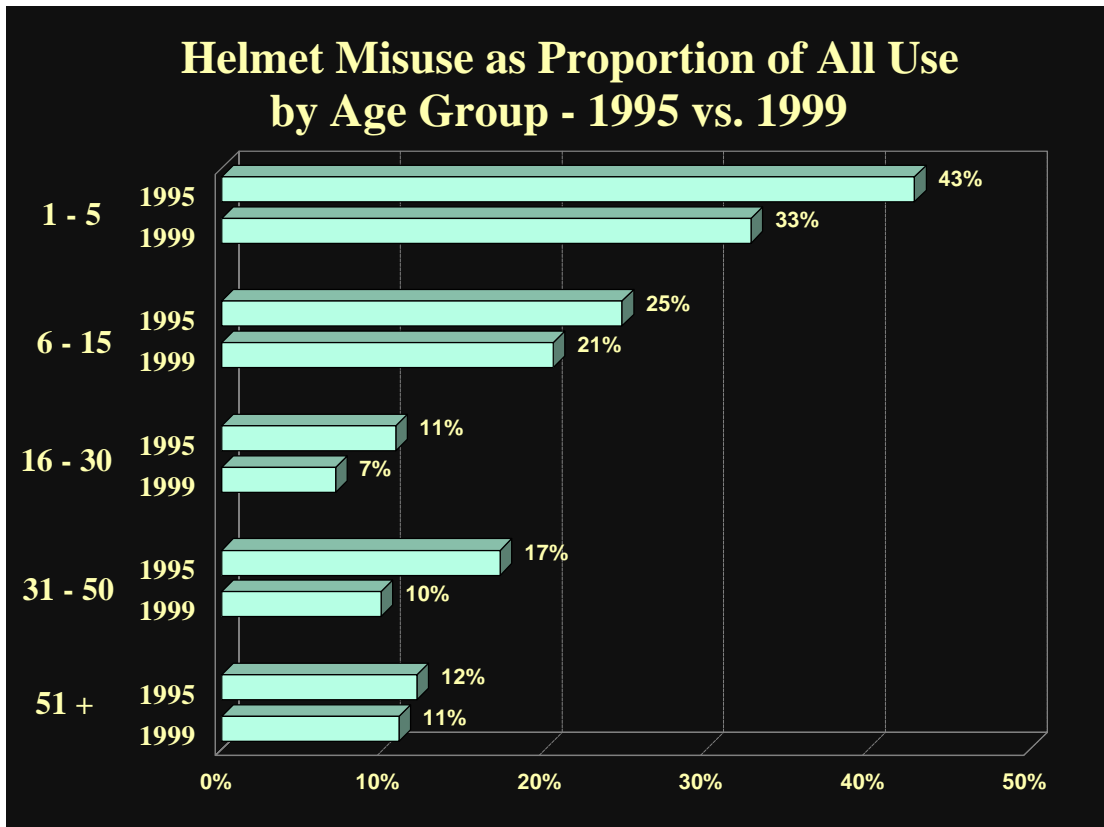


Figure 7

situations, and as a result are more likely to be injured or killed than are very young riders, who are often observed riding in the company of adults.

Helmet misuse rates across the various categories of bicyclists observed are shown in Table 1. Between 1995 and 1999 the sex difference in misuse declined dramatically from 24% vs. 12% among females and males respectively to 14% (male) vs. 10% (female), but the difference remains statistically significant. Misuse declined similarly across type of bicycle ridden, but remains dramatically different, with riders of 'other' bikes continuing to have a high rate of misuse (21%).

**Table 1 Percent of Helmets Worn Incorrectly by Bicyclist Category**

<b>Category</b>	<b>1995</b>	<b>1999</b>
Male	12%	10%
Female	24	14
Mountain bike	15	11
Road bike	8	5
Other	33	21
Commuter site	11	9
Recreation site	17	12
Neighborhood	16	13
Community	18	12
Metropolitan area	14	10
Non-metropolitan	21	15

**Summary of Change in Helmet Use**

Table 2 presents a summary of the increase in helmet use across the various subcategories of bicyclists observed. The values in this table are the odds-ratio<sup>3</sup>, a statistic useful for making a standardized comparison. This avoids the problems of interpretation presented when assessing the amount of change for two groups that began at different levels of helmet use. As presented here, this measure can be interpreted as the increase in likelihood of a bicyclist in a given group wearing a helmet in 1999 vs. 1995. Thus, the odds-ratio of 3.2 for females indicates that in 1999 female bicyclists were 3.2 times more likely to have been observed wearing a helmet than in 1995. Similarly, males were 2.6 more likely to have been seen wearing a helmet in 1999 compared to 1995.

## **DISCUSSION**

Although helmet use throughout British Columbia was already high in comparison to other north American jurisdictions, it increased markedly between 1995, prior to the helmet law taking effect, and 1999 nearly three years after the law was enacted. As mentioned above, it would have been of interest to know how helmet use changed shortly after the law took effect. Although it was not possible to determine that, the rates of helmet wearing reported here are comparable to what has been found in other jurisdictions (New Zealand, Australia) shortly after comprehensive helmet use laws took effect. Hence, it is likely either that helmet wearing increased to even higher levels shortly after the law took effect and slowly eroded to the levels found about 33 months later or that wearing rates increased to about the levels reported here and have remained relatively stable.

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<sup>3</sup> As its name implies, this statistic is simply a ratio of two odds. In this case, it is the ratio of the odds (or likelihood) of a cyclist wearing a helmet in 1999 vs. the odds in 1995. As an example, the overall likelihood of helmet use by males in 1999 was 2.1 (68%/32%) and in 1995 it was .8 (44%/56%). Hence the ratio of these is 2.6 (2.1/.8), so the likelihood of helmet use by males in 1999 was 2.6 times as great as in 1995.

**Table 2 Change in Likelihood of Helmet Use by Bicyclist Category**

<b>Category</b>	<b>Odds-Ratio</b>	<b>95% Confidence Interval*</b>
Male	2.61	2.34, 2.90
Female	3.2	2.68, 3.82
≤ 5years	2.32	1.14, 4.71
6 - 15	2.93	2.38, 3.61
16 - 30	2.52	2.18, 2.90
31 - 50	2.74	2.29, 3.27
51 +	3.85	2.65, 5.59
Mountain bike	2.95	2.65, 3.28
Road bike	2.68	2.05, 3.50
Other	2.17	1.69, 2.79
Commuter site	2.00	1.63, 2.46
Recreation site	3.12	2.65, 3.68
Neighborhood	4.00	3.24, 4.94
Community	2.35	1.98, 2.78
Metropolitan area	2.74	2.47, 3.05
Non-metropolitan	2.92	2.43, 3.51

Beyond the fairly substantial increases in helmet wearing that followed the law, probably the most striking finding of the present study is the breadth of the effect. Although differences in the extent of helmet use remain in various subgroups, the increase was similar in most every subgroup we examined. With the exception of persons over age 50 and those seen riding in neighborhoods, the likelihood of

helmet use in 1999 ranged from about two to just over three times as likely, suggesting that there are no particular pockets of resistance to the law, or that if any existed, they had eroded by the summer of 1999.

There are two areas of some concern in the present findings. First is the continued lower rate of use among children in the 6 - 15 year-old age group. This is a group where, for a variety of reasons, injuries tend to be more common than among either younger or older bicyclists. They ride more than younger children and they ride more carelessly than older bicyclists. The much higher rate of helmet misuse among those children who are wearing one is cause for concern as well. Although a poorly adjusted helmet may provide some protection in certain kinds of crashes or falls, it will not perform as it was designed to. A recent study by Rivara et al. (1999) clearly indicates that children who have had a fall or collision who were wearing poor fitting helmets were more likely to be injured than those whose helmets were properly fitted. Both these findings suggest that serious effort should be devoted to ensuring that parents recognize the risks of helmet non-use or misuse to their children and are assisted in addressing the current low rate of correct use among this vulnerable population.

It is encouraging to find that helmet misuse had decreased between 1995 and 1999. Often, mandating the use of a safety device that is not easily used correctly can increase misuse since a law brings less motivated individuals into compliance. Whereas "early adopters" of a safety practice are typically highly motivated and attentive to correct use due to their concern for the issue of safety, those who are motivated only by the fact that it is required can be less concerned about correct use. For whatever reason, that has not been the case the helmet use in British Columbia

Some caution is warranted in interpreting the findings reported here. It seems apparent that the increases in helmet wearing to the high levels observed were due to enactment of the helmet law. However, the research design employed does not allow us to draw that conclusion unequivocally. Because we had no comparison group not exposed to a law, it is possible that helmet use has been increasing (at least in this general region of the continent) and that some, if not all, of the increase

is simply due to that general trend. However, although this is possible, it is highly unlikely. Safety-related behaviors like helmet use tend to change only very gradually in the absence of any intensive intervention.

Another possibility is that helmet promotion activities that have occurred in British Columbia since 1995 may have served to increase helmet use independent of the law. There has been relatively little effort devoted to publicizing the helmet law itself. The government of British Columbia funded the development of a new comprehensive safe cycling program to provide elementary school children training in safe-cycling practices, boost public awareness about cycling safety, and enhance cycling throughout the province. The safe cycling education program, called "Bike Smarts", was geared to children in grades 3 through 7. This program covered rules of the road, the importance of protective equipment such as bicycle helmets, bicycle handling skills, understanding traffic signals and hands-on practice in group bicycle riding sessions. Although this program may have affected helmet use, and the somewhat greater increase in use among the 6-15 age group may attest to that, this program would not likely have affected the wide diversity of groups that showed similar, or greater increases in helmet use.

A public awareness campaign was also mounted in the media, schools, public forums and through stakeholder groups such as the B.C. Injury Prevention Centre, B.C. Medical Association, Cycling B.C. and the Vancouver Island Safety Council. A brochure, poster and newspaper advertisement promotion was developed and launched in the summer of 1995 using the tag line "Are you in the right gear." A bicycle helmet \$10 rebate program also helped families purchase helmets for children. This program may have helped to account for the relatively high levels of helmet use seen in the 1995 survey. The government's involvement in the program wound down in the spring of 1997 and the effects of such programs are known to be relatively short-lived.

Hence, the helmet law remains as the only plausible explanation for the broad, substantial increase in helmet wearing from 1995 to 1999. It contributed substantially to this increase, and in all likelihood is responsible for the majority of the change. Moreover, it would appear the helmet law has had something of a

leveling effect, bringing those groups that had lower rates of use closer to the wearing rates among groups that previously were among the highest.

Although some self-report studies have indicated similarly high helmet use rates (Rodgers, 1995), this method of collecting information about the use of safety devices is notoriously unreliable, with substantial overreporting being the norm. When considering only observational data, the helmet wearing rate prior to the law in British Columbia was one of the highest ever documented. The findings reported here attest to the value of a comprehensive helmet use law, even in those settings where helmet use is encouragingly high anyway. Finally, it is worth noting that the British Columbia law probably obtained much of its effect from the fact that it applies to all bicyclists regardless of age. Certainly such a comprehensive law will affect a wider age group than one limited to children, but beyond that it is likely that a comprehensive law is also more likely to be known and understood than one that applies only to a limited demographic or demographic population (Puder et al., 1999).

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