Graduated licensing for motorcyclists

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May 2001

ISBN: 0-920071-15-5

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Financial support provided by:

Motorcycle & Moped Industry Council

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Executive Summary

Purpose

Over the past decade, in an effort to reduce collisions involving new drivers, including those who operate motorcycles, several jurisdictions in North America have implemented a new system of licensing called graduated driver licensing. The system phases in on-road driving, allowing beginners to gain their initial experience under conditions that are less risky. This is accomplished through a multi-stage licensing program that includes two key components: an extended learners stage, during which driving is only permitted under supervision (usually for a period of six months or more); followed by an intermediate stage of unsupervised driving that is restricted to low risk conditions – e.g., driving alone only during the day, having a zero BAC.

This report describes graduated motorcycle licensing programs in place, or currently being considered, in Canada and the United States as well as other restrictive measures that have been applied in motorcycle licensing systems in several U.S. states. These programs typically apply to new applicants for a motorcycle licence, who do not have a licence to operate a car. These applicants are novices in two respects: they are inexperienced at operating a motorcycle, which is more demanding than a car, and they have no other driving experience.

The report also considers the safety value of graduated licensing for novice motorcyclists. It discusses the scientific evidence on the safety benefits of different licensing programs targeting novice motorcyclists and examines available crash data to address this issue.

Current Practices

Six jurisdictions in Canada have implemented some version of graduated licensing for motorcyclists – Ontario (1994), Nova Scotia (1994), Quebec (1997), British Columbia

(1998), Newfoundland (1999), and the Yukon (2000). Three jurisdictions – Alberta, Saskatchewan and Manitoba – are currently considering the implementation of graduated licensing for motorcyclists.

Three U.S. states – California (1998), Maryland (1999) and South Dakota (1999) have adopted some version of graduated licensing for novice motorcyclists. Several other states apply restrictions in the learner motorcycle permit stage and a few restrict novice drivers in some or all age groups to operating motorcycles of specific sizes.

Current and planned graduated licensing systems for novice motorcycle riders vary substantially in their operational features – e.g., in terms of the restrictions selected, how they are applied and to whom, over what period of time, what sanctions are applied to violators, and so on. This flexibility is an attractive feature of graduated licensing, because it can be tailored to the particular needs of a jurisdiction. However, in designing a graduated licensing system, it is critical that its features are true to the basic prevention principle of providing opportunities to obtain driving experience under conditions that minimize exposure to risk. In addition, the elements of the system should be based, to the extent possible, on scientific evidence and proven effectiveness.

Safety Impact

Most graduated motorcycle licensing programs have only been recently introduced so few have been formally evaluated. There is evidence, however, that the programs adopted in New Zealand and, possibly in Quebec, have been effective in reducing collisions. Moreover, research suggests that specific restrictions, typically included in graduated driver licensing programs for passenger vehicle drivers and motorcyclists, reduce collisions – e.g., supervision at all times, daylight driving only, zero BAC limits. The scientific evidence is considerably less compelling for engine size/power limits. Although research is lacking for other restrictions, such as certified driving practice, these measures are consistent with the rationale of graduated driver licensing.

Recommendations

Until further evaluations and studies are undertaken and completed, it is difficult to identify the optimal requirements and features of a graduated licensing program for novice motorcyclists. However, reviews of programs, both in place and planned, as well as of the scientific evidence on key features provide at least some guidance for structuring an optimal program.

At a minimum, a model program would involve three stages:

- The first is an extended learners stage, during which driving would be permitted only under the supervision of a fully licensed motorcyclist, following closely on another motorcycle or in a passenger vehicle. During this critical "learning to ride" stage, the novice would be required to have a minimum number of hours of practice, certified by their supervisor and/or parent. Riding under supervision would be allowed only during daylight hours (sunrise to sunset) because the novice must be seen by the supervisor – i.e., supervision on another motorcycle or in a passenger vehicle may be difficult and impractical during hours of darkness. Since supervision may also be impractical on certain types of roads – e.g., expressways – and at higher speeds, road and/or speed restrictions would apply. No passengers would be permitted and the learner would need to display an "L" plate on the motorcycle. There would be a zero BAC limit applied to the learner and a low or zero BAC limit for the supervisor as well.

- The intermediate stage would permit unsupervised driving but only in less risky situations such as during the day. During riskier night hours – e.g., from 9:00 pm or 10:00 pm until 5:00 am – and when riding on certain types of higher speed roads – e.g., freeways, roads with posted speed limits over 90 km/hr -- the novice would be required to have a fully qualified motorcyclist as a supervisor seated behind them, or in a sidecar. In fact, during the first few months on this stage, only a fully licensed motorcyclist would be allowed as a passenger to supervise the novices' initial experiences carrying someone else on the motorcycle. In addition, during these first few months or, for the full intermediate period, passengers under 20 would not be

allowed. After the first few months, other passengers would be allowed during unsupervised riding – e.g., during the day and on lower speed roads. The novice would be required to display an "N" plate on the motorcycle in this intermediate stage. There would be a zero BAC limit applied to the novice and a low or zero BAC limit for the supervisor as well.

- The third and final stage, a full privilege licence, would become available when conditions of the first two stages have been met – e.g., a crash- and violation-free record; passing initial off-road (e.g., balance) test and on-road skills tests, and later even a more advanced exit test that focuses on higher-order skills such as hazard perception.

Performance-based, advanced skills tests ensure the novice has achieved the minimum standards of safe riding and serve as incentives for them to acquire the skills and experience needed to pass these tests.

Integrating rider education and training could potentially enhance the effectiveness of graduated driver licensing. However, efforts should be made to improve the form and content of existing education and training programs because the safety benefits of the programs that have been evaluated to date remain unproven.

1.0 Introduction

Over the past decade, in an effort to reduce collisions involving new drivers, including those who operate motorcycles, several jurisdictions in North America have implemented a new system of licensing called graduated driver licensing. This licensing concept was initially developed in the mid- to late-1970s (Croke and Wilson 1977) to address the elevated crash risk of novice drivers, particularly young ones, of passenger vehicles. The system phases in on-road driving, allowing beginners to gain their initial experience under conditions that are less risky. This is accomplished through a multi-stage licensing program that includes two key components: an extended learners stage, during which driving is only permitted under supervision (usually for a period of six months or more); followed by an intermediate stage of unsupervised driving that is restricted to low risk conditions – e.g., driving solo only during the day, a zero BAC.

Since 1994, seven jurisdictions in Canada and 25 in the United States have implemented some version of graduated licensing for novice drivers of passenger vehicles. Although, the graduated licensing concept was developed for novices of passenger vehicles, not motorcycles, several of these jurisdictions, principally in Canada, have extended the concept to novice motorcycle drivers. In addition, several U.S. states apply restrictions in the learner motorcycle permit stage and a few restrict novice drivers in some or all age groups to operating motorcycles of specific sizes. Such programs are conceptually similar to graduated licensing.

This report describes these motorcycle licensing practices as well as those now being considered by jurisdictions that plan on implementing graduated licensing programs for operators of both passenger vehicles and motorcycles.

The report also considers the safety value of graduated licensing for novice motorcyclists. In this regard, evidence is growing that graduated licensing for drivers of passenger vehicles reduces crashes (Mayhew 2000). However, few studies have focused on the safety impact of graduated licensing or other restrictive practices for

motorcyclists. This report discusses the scientific evidence on the safety impact of different licensing programs targeting novice motorcyclists and examines available crash data to address this issue.

1.1 The Context

Over the past decade, there has been a dramatic drop in the number of motorcyclists killed in Canada – in 1987, there were 358 motorcyclists killed in road crashes; in 1997, that number had declined to 123 (a 65.6% decrease). Of some importance, however, *the decline in deaths halted abruptly in 1997 – in 1998, the number of motorcyclists killed increased to 165 (a 34.6% increase)*.

Although the number of motorcyclists killed dropped again in 1999 – from 165 to 159 deaths – motorcyclists continue to be over-represented in crashes. In 1999, motorcycles accounted for only 2% of the registered vehicles in Canada but 5% of all road user fatalities and 3% of all road user injuries (1998 figure).

Sixteen of the deaths in 1999 were to young motorcyclists (age 15-19); a further 729 of them were injured that year. These casualty figures will likely increase in the coming years because the youth population in Canada is expected to grow by about 12% between now and the year 2011 (Mayhew and Simpson 1999).

These findings underscore the need for effective solutions to address the problem of motorcycle crashes. And in this regard, as early as 1968, researchers identified motorcyclist testing and licensing as the most promising means of achieving long-term, cost-effective crash reduction (Reiss et al. 1968). More recently, graduated licensing, a concept initially developed to address the elevated crash risk of novice drivers of passenger vehicles, has been implemented as a promising solution to the problem of motorcycle crashes. This system typically applies to new applicants for a motorcycle licence who have never held a driver's licence. These applicants are novices in two respects: they are inexperienced at operating a motorcycle, which is more demanding than a car, and they have no other driving experience.

Graduated licensing for novice motorcyclists is intuitively appealing because novice motorcyclists have an elevated fatal crash risk even greater than novices operating passenger vehicles. The primary reasons for the higher crash risk of novice drivers of both passenger vehicles and motorcycles are driving inexperience and youth-related factors, such as immaturity and a greater propensity to take risks. Accordingly, novice motorcyclists, particularly young ones should also benefit from a graduated licensing approach that allows them to gain their initial "on road" experience under conditions that are less risky.

At issue for this report are current graduated driver licensing and other restrictive practices, and the safety benefits of these licence programs for beginner motorcyclists.

1.2 METHOD

The project involved the following three interrelated tasks: a survey, a literature review and data analyses.

1.2.1 Survey

Contemporary information on current graduated motorcycle licensing programs as well as other restrictive licensing practices in Canada and the United States were gathered by means of a survey. In Canada, all members of the CCMTA Road Safety Research and Policy Committee and/or the Drivers and Vehicles Committee from each of the 12 jurisdictions were contacted by telephone. This included the seven jurisdictions that currently have a version of graduated licensing – Ontario, Nova Scotia, New Brunswick, Newfoundland, Quebec, British Columbia, and the Yukon – as well as the five that do not – Alberta, Saskatchewan, Manitoba, Prince Edward Island, and the Northwest Territories. The other non-GDL jurisdictions were included because they all have recently considered the adoption of graduated licensing, including applying the concept to novice motorcyclists as well. In the United States, select states were surveyed that have implemented graduated licensing for motorcyclists or have in place some form of restrictive licensing practices.

Several national agencies in the United States were also contacted – e.g., the Motorcycle Safety Foundation (MSF), the American Association of Motor Vehicle Administrators (AAMVA), the Insurance Institute for Highway Safety (IIHS), and the National Highway Traffic Safety Administration (NHTSA) – to determine their current position on, and thoughts on applying, graduated driver licensing to novice motorcyclists.

The survey obtained detailed information about relevant programs, including copies of descriptive materials – e.g., driver handbooks – and commentary and documentation on the extent to which there is evidence that the program has been effective in reducing motorcycle crashes.

1.2.2 Literature Review

Recent scientific papers and technical reports on the safety effectiveness of graduated licensing programs and other restrictive practices for novice motorcyclists were obtained and critically reviewed. This included evaluations outside of North America – e.g., the graduated motorcycle-licensing program in New Zealand has recently been evaluated.

1.2.3 Data Analysis: Effectiveness of Graduated Licensing

The literature review and survey of key contacts provided some information on the safety effectiveness of graduated licensing for novice motorcyclists. However, there is not much scientific evidence on this issue. Accordingly, the project also involved the analysis of available secondary data on motorcycle crashes in Canada. Statistical information provided in Transport Canada's Traffic Collision Statistics report as well as provincial Road Safety Annual reports were used for this purpose. In addition, annual motor vehicle crash data sets from two jurisdictions with graduated motorcycle licensing programs – i.e., Ontario and Nova Scotia – were analysed. These data sets were examined to determine if the number of motorcycle crashes involving young drivers – those likely to be novice riders and, consequently, most affected by the program – decreased following implementation of the graduated licensing programs.

The above analyses provided some information on the safety effectiveness of graduated licensing as well as the relative effectiveness of different programs. However, it is important to understand that an analysis based largely on available secondary data does not constitute a comprehensive, definitive evaluation of these programs. Accordingly, the results of the analyses reported here provide suggestive, **not definitive**, evidence on the extent to which graduated licensing programs for motorcyclists have had a beneficial safety impact.

2.0 Graduated Licensing and Other Restrictive Practices

This section describes graduated motorcycle licensing programs in place, or currently being considered, in Canada and the United States. It also considers other restrictive measures that have been applied in the motorcycle licensing systems in several U.S. states.

In some of these jurisdictions, graduated motorcycle licensing only applies if the applicant has never held a driver's licence. If the applicant has a driver's licence, they do not have to enter the motorcycle graduated licensing program and have fewer steps to go through to obtain a motorcycle licence or endorsement. The motorcycle licensing requirements for drivers who already have a passenger vehicle licence are not described in this report.

2.1 Graduated Licensing In Canada

Since 1994, the following seven jurisdictions in Canada have implemented some version of graduated licensing for novice drivers of passenger vehicles – Ontario (April 1994), Nova Scotia (October 1994), New Brunswick (January 1996), Quebec (July 1997), British Columbia (August 1998), Newfoundland (January 1999), and the Yukon (September 2000). All these jurisdictions, with the exception of New Brunswick, also implemented a version of graduated licensing for novice motorcyclists.

Three jurisdictions – Alberta, Saskatchewan and Manitoba – are currently considering the implementation of graduated licensing for passenger vehicle and motorcycle drivers. Proposed or tentative programs have been developed in Saskatchewan and Manitoba for public discussion. The proposed model in Manitoba is described in a report by the Graduated Licensing Task Force (June 2000); the proposed model in Saskatchewan is described in a recent report by Saskatchewan Government Insurance (Quaye, pers.com. 2001). Alberta is currently considering the features of a graduated licensing program for

novice motorcycles but has not yet developed a proposed model (Brooks, pers. com. 2001).

The features of each current and proposed program are described below and then summarized in Table 1 (see page 16).

2.1.1 Ontario (*April 1994*)

LEVEL 1

Entry Requirements:

- At least 16 years old
- Pass vision test and knowledge test about the rules of the road and traffic signs
- Pass written motorcycle knowledge test

Features:

- Mandatory 60 days
- Zero BAC
- Drive only during daylight hours (one-half hour before sunrise to one-half hour after sunset)
- Drive only on roads with speed limits of 80 km/h or less (except where there is no other route)
- No passengers

LEVEL 2

Entry Requirements:

- Pass road test, either as part of an approved motorcycle safety course or at a Driver Examination Center

Features:

- Mandatory 22 months (or 18 months with approved motorcycle safety course)
- Zero BAC

Exit Requirements:

- Pass advanced on-road exit test

2.1.2 Nova Scotia (*October 1994*)

LEVEL 1

Entry Requirements:

- At least 16 years old
- Obtain learner driver's licence (pass vision, road signs, traffic and safety rules tests)
- Complete motorcycle rules test
- Complete practical skills test – i.e., balance test

Features:

- Mandatory 6 months (or 3 months with approved motorcycle course)
- Zero BAC
- Drive only during daylight hours (one-half hour before sunrise to one-half hour after sunset)
- No passengers

LEVEL 2

Entry Requirements:

- Advance on-road skills test

Features:

- Mandatory 24 months
- No driving between midnight and 5 a.m.
- Zero BAC

Exit Requirement:

- Complete approved motorcycle driver improvement program

2.1.3 Quebec *(July 1997)*

In Quebec, there are three licences for motorcycles defined in terms of engine size: 1) for any motorcycle; 2) for a motorcycle with an engine capacity of 400 cc or less; and 3) for a motorcycle with an engine capacity of 125 cc or less. The novice becomes licensed for the engine capacity of the motorcycle they plan on riding. This tiered licensing approach was in place prior to the implementation of the graduated licensing program for novice motorcyclists.

LEVEL 1

Entry Requirements:

- At least 16 years old
- Pass motorcycle knowledge test to qualify for mandatory rider training
- Complete mandatory rider training (since July 2000) for issuance of second learner permit (since January 2001)

Features:

- Mandatory 8 months (initially 12 months, revised January 2001)
- A first learner permit is issued for a minimum of 1 month when driving is only allowed within the mandatory rider training course
- After passing practical off-road test a second learner's permit is issued for a minimum of 7 months
- Supervised by licensed motorcyclist (with two years driving experience) on another motorcycle
- Zero BAC
- No passengers

LEVEL 2

Entry Requirements:

- Pass road test
- Under 25 years old; if older than 25 can apply for a regular motorcycle licence

Features:

- Mandatory 24 months or until age 25
- Zero BAC

Exit Requirements:

- None

2.1.4 British Columbia (*August 1998*)

LEVEL 1

Entry Requirements:

- At least 16 years old
- Obtain learner driver's licence (pass vision and medical condition screening, passenger vehicle knowledge test)
- Pass motorcycle knowledge test

Features:

- Mandatory 6 months (or 3 with driver education course)
- First 30 days, practice only where you can be seen by your supervisor (line-of-sight rule); supervisor must have a valid motorcycle licence and be 19 years of age or older

- After 30 days, motorcycle skills test (off-road on paved lot) and if successful ride unsupervised
- Zero BAC
- “L” New Driver sign
- No passengers
- Only during daylight hours (between sunrise and sunset)
- Drive under 60 km/h
- No freeway driving

LEVEL 2

Entry Requirements:

- Pass road test

Features:

- Mandatory 18-months
- Zero BAC
- Display “N” new driver sign

Exit Requirements:

- Pass advanced on-road motorcycle test, including a hazard perception test as a passenger in a vehicle driven by the examiner.

2.1.5 Newfoundland *(January 1999)*

LEVEL 1

Entry Requirements:

- At least 16 years old
- Pass skills, knowledge and vision tests

Features:

- Mandatory 12 months (or 8 months with motorcycle training program)
- Supervised by licensed motorcycle driver on another cycle, or in a motor vehicle
- Zero BAC
- .05 BAC for supervising driver
- No passengers
- No driving one half hour before sunset and one half hour after sunset
- No driving on highways where speed limit is above 80 km/h

LEVEL 2

Entry Requirements:

- Pass road test

Features:

- Mandatory 12 months
- Zero BAC
- No driving between midnight and 5 am

Exit Requirements:

- None

2.1.6 Yukon (*September 2000*)

LEVEL 1

Entry Requirements:

- At least 15 years old
- Pass written motorcycle knowledge test
- Pass vision test

Features:

- Mandatory 6 months
- Accompanied by a co-driver at all times (seated behind the learner or following close in another motorcycle/motor vehicle – recommended co-driver follow in or on another vehicle); must hold a valid motorcycle licence for at least two years
- Zero BAC
- No passengers
- No driving between midnight and 5:00 pm\No driving after daylight
- Minimum of 30 hours certified practice driving with a qualified co-driver (or professional instructor)
- L sign

LEVEL 2

Entry Requirements:

- Pass road test
- At least 16 years old

Features:

- Mandatory 18-months
- Supervision when driving between midnight and 5:00 am
- Zero BAC
- No passengers under 13 years of age

Exit Requirements:

- None

2.1.7 Manitoba *(proposed, tentative)*

LEVEL 1

Entry Requirements:

- At least 16 years old
- Pass written knowledge test and vision test
- Practice with a licensed motorcyclist supervising for a minimum of 30 days off roadways
- Pass a motorcycle skills test
- Pass an approved motorcycle training course

Features:

- Mandatory 12 months
- Zero BAC
- Drive in daylight hours (1/2 hour after sunrise, ½ hour before sunset)
- No passengers
- L plate/sign

LEVEL 2

Entry Requirements:

- Pass road test

Features:

- Mandatory 12 months, maximum 2 years or primary road retest
- Zero BAC
- Distinguishable licence plate/sign

LEVEL 3 (Probationary)

Entry Requirements:

- Pass advanced road test

Features:

- Mandatory 12 months
- Zero BAC

Exit Requirements:

- None

2.1.8 Saskatchewan (*proposed, tentative*)

LEVEL 1

Entry Requirements:

- Minimum age 16
- Pass written knowledge test

Features:

- Mandatory 6 months (no reduction for driver education)
- Supervising driver, fully licensed motorcyclist (minimum 2 years driving experience); cannot be a novice driver
- No passengers
- Zero BAC for beginner
- .04 BAC for supervising driver
- Daylight hours only
- Mandatory driver education: 4 hours (commercial); 30 hours classroom and 6 hours in car (high school driver education)
- No driving on highway with speed limit over 80 km/h

LEVEL 2

Entry Requirements:

- Pass road test

Features:

- Mandatory 24 months
- Zero BAC
- Midnight to 5:00 am curfew
- Complete approved motorcycle course

Exit Requirements:

- None

2.1.9 Alberta *(under consideration)*

LEVEL 1

Entry Requirements:

- At least 16
- Pass vision test and knowledge test

Features:

- Mandatory 12 months
- Zero BAC
- Daylight driving only

LEVEL 2

Entry Requirements:

- Road test

Features:

- Mandatory 24 months
- Zero BAC

Exit Requirements:

- Advanced road test

2.1.10 Summary

The key features of graduated licensing programs in Canada are summarized in Table 1 on the next page. As can be seen, there is considerable variation across jurisdictions, although there are a few similarities. All jurisdictions have adopted or are considering multi-phased graduated licensing comprised of a learner's stage and an intermediate stage. The only exception is Manitoba, where an additional probationary stage is under consideration. The features of each of these stages are summarized below.

Level 1: Learner stage. In all jurisdictions, some form of testing is required to qualify for a learner's motorcycle licence and this includes tests for a learner's driver licence – knowledge and vision -- as well as the motorcycle knowledge test. A few jurisdictions also require the beginner to pass a motorcycle skill test which is administered off-road so that the novice can demonstrate handling skills and ability to maneuver the motorcycle under low speed conditions.

The minimum age for obtaining a learner's licence is 16 years in all jurisdictions except the Yukon where the minimum age has been set at 15 years. In Alberta, the minimum age for learner motorcyclists that is currently being considered is 16 years, even though the minimum age for learner drivers of passenger vehicles is 14 years.

The holding period for the learner's licence ranges from 60 days in Ontario to 12 months in Newfoundland and Manitoba (proposed). In three jurisdictions this minimum length of time in the learners stage can be reduced with successful completion of a motorcycle

Table 1: Learner Stage
(Level 1)

Jurisdiction	Entry Age	Mandatory Holding Period	Supervisor	Passenger Restrictions	BAC Level	Night Driving Restriction	Certified Practice	Road Restriction	L Sign/ Plate	Exit Test	Driver/Rider Education
Ontario	16	60 days	None	No pass.	Zero	In daylight only	None	< 80 km/h	None	Road	None
Nova Scotia	16	6 months (3 with course)	None	No pass.	Zero	In daylight only	None	None	None	Road	None
Quebec	16	8 months	Lic. m'cycle driver	No pass.	Zero	None	None	None	None	Road	M'cycle training
British Columbia	16	6 months (3 with course)	First 30 days	No pass.	Zero	In daylight only	None	< 60 km/h No freeways	L sign	Road	None
Newfoundland	16	12 months (8 with course)	Lic. m'cycle driver	No pass.	Zero	In daylight only	None	< 80 km/h	None	Road	None
Yukon	15	6 months	Lic. m'cycle driver	No pass.	Zero	Midnight-5:00am daylight only	30 hours	None	L sign	Road	None
Manitoba (proposed)	16	12 months	None	No pass.	Zero	In daylight only	None	None	L plate/sign	Road	None
Saskatchewan (proposed)	16	6 months	Lic. m'cycle driver	No pass.	Zero	In daylight only	None	< 80 km/h	None	Road	Driver ed
Alberta (under cons.)	16	12 months	Lic. m'cycle driver	No pass.	Zero	In daylight only	None	None	None	Road	None

Table 1: Intermediate Stage
(Level 2)

Jurisdiction	Mandatory Holding Period	Passenger Restrictions	BAC Level	Night Driving Restriction	Road Restriction	L Sign/ Plate	Exit Test	Driver/Rider Education
Ontario	22 months (18 with course)	None	Zero	None	None	None	On-road	None
Nova Scotia	24 months	None	Zero	Midnight-5:00 AM	None	None	None pass course	M'cycle course
Quebec	24 months	None	Zero	None	None	None	None	None
British Columbia	18 months	None	Zero	None	None	"N" sign	On-road	None
Newfoundland	12 months	None	Zero	Midnight-5:00 AM	None	None	None	None
Yukon	18 months	No pass. under age 13	Zero	Midnight-5:00 AM unsupervised	None	None	None	None
Manitoba (proposed)	12 months	None	Zero	No night driving	None	Yes	On-road	None
Saskatchewan (proposed)	24 months	None	Zero	Midnight-5:00 AM	None	None	None	M'cycle course
Alberta (under cons.)	24 months	None	Zero	None	None	None	On-road	None

training program – from 6 months to 3 in Nova Scotia and British Columbia; from 12 months to 8 in Newfoundland.

Six of the nine jurisdictions require supervised driving at all times by a fully licensed motorcyclist. In Quebec, the supervisor is required to be following closely on another motorcycle. In Newfoundland, the supervisor can be on another motorcycle or in a motor vehicle. In the Yukon, the supervisor can be on another motorcycle, or in a motor vehicle, or seated behind the learner, although this later option is not recommended by the licensing authority.

Supervised driving is only required for the first 30 days of the 6-month learner holding period in British Columbia. However, the learner must pass a motorcycle skills test administered off-road on a paved lot before being granted unsupervised driving privileges. Although the proposed program being considered in Manitoba does not require supervised driving during the learner stage, it does include, as an entry requirement, practice driving with a licensed motorcyclist supervising for a minimum of 30 days off-road.

In all jurisdictions, passengers are not allowed on the learner's motorcycle and the learner is subject to a zero BAC limit – i.e., absolutely no drinking and driving. A few jurisdictions also apply a low BAC limit on supervising drivers -- .04 in Saskatchewan, .05 in Newfoundland.

In all jurisdictions except Quebec, learner motorcyclists are only allowed to drive during daylight hours – e.g., ½ hour after sunrise, ½ hour before sunset. In the Yukon, a midnight to 5:00 a.m. driving restriction is also applied because of the long periods of daylight during part of the year.

Only one jurisdiction – the Yukon – requires parents or supervisors to certify that a certain number of hours have been driven under supervision. The requirement is a minimum of 30 hours certified practice driving with a "co-driver" or a professional driving instructor.

Several jurisdictions restrict learners from driving on highways where the speed limit is above 80 km/h. British Columbia imposes a road restriction – i.e. no freeways – as well as a speed restriction – i.e., the learner must drive under 60 km/h.

Three of the nine jurisdictions require learner motorcyclists to display an "L" sign or plate at all times during practice driving – British Columbia, the Yukon, and Manitoba (proposed).

In Quebec, learners are initially required to successfully complete a practical motorcycle training program – two learner permits are issued: the first one for a minimum of 1 month when driving is restricted to within the training course; the second one for a minimum of 7 months after successfully completing a practical off-street test. The proposed program in Saskatchewan includes mandatory driver education in the learner stage.

Level 2: Intermediate stage. The mandatory holding period ranges from 12 months to 24 months. Most of the restrictions applied in Level 1 are dropped in the intermediate stage with the exception of the zero BAC limit.

Novice motorcyclists are allowed to carry passengers in all jurisdictions during the intermediate stage. However, in the Yukon, the passenger must be aged 13 or older.

Four of the nine jurisdictions include a night restriction, typically from midnight to 5:00 a.m. In the Yukon, supervised driving is allowed during these night hours.
Only two jurisdictions require novices to display an "N" sign or plate on their motorcycle – British Columbia and Manitoba (proposed).

An advanced, on-road, motorcycle skills test is required to exit the intermediate stage and obtain a motorcycle driver licence in Ontario and British Columbia. Such an exit test has been proposed in Manitoba and is also under consideration in Alberta.

Nova Scotia requires novice motorcyclists to complete a motorcycle driver improvement course to graduate to a full motorcycle licence; a motorcycle course has also been proposed in Saskatchewan.

Learner licence holders and intermediate licenced motorcyclists are also typically subject to a more stringent penalty point system for traffic infractions than fully licensed motorcyclists -- fewer demerit points result in a licence suspension. For example, in Quebec the limit is 4 demerit points for novices as opposed to 15 for a regular licensed driver. The accumulation of 4 demerit points results in a 3-month licence suspension and the lengthening of the learner or intermediate period by that amount of time. In some jurisdictions, breaking any of the conditions of the program will result in a licence suspension – e.g., in Ontario, the suspension period is for 30 days.

2.2 Graduated Licensing in the United States

Graduated licensing for novice drivers of passenger vehicles has become increasingly popular in the United States – 25 states have already enacted some form of graduated licensing and others are currently planning on doing so. Despite this trend, and unlike developments in Canada described in the previous section, few states – only California, Maryland and South Dakota – have adopted some version of graduated licensing for motorcyclists. This is the case even though three influential U.S. agencies – the Motorcycle Safety Foundation (MSF), the National Highway Traffic Safety Administration (NHTSA), and the American Association of Motor Vehicle Administrators (AAMVA) – have developed a model "Motorcycle Operator Licensing System", that contains features of graduated licensing (AAMVA 1997). This model is intended to provide guidance to state motor vehicle administrators interested in improving their motorcycle licensing program.

The reasons graduated licensing for motorcyclists has not been widely adopted in the United States are unclear. Given that in many states some restrictions are already in place at least for learner motorcyclists, it is possible that these states do not feel a strong need for graduated licensing. As well, most states have motorcycle safety programs that focus primarily on rider education and testing, so graduated licensing may not be viewed as necessary. In this regard, although the "National Agenda for Motorcycle Safety" (NHTSA 2001) recently developed by NHTSA and MSF addresses licensing issues, the implementation of graduated licensing was not among the following four "urgent" recommendations: research in motorcycle crashes, motorcyclists alcohol and substance

impairment, personal protective equipment (increase use of compliant helmets), and motorist awareness. Other reasons that have been offered are that:

> In most states, the motorcycle licence is just an endorsement on the driver licence and a great majority of riders get a drivers licence first. Superimposing a graduated process on the endorsement would be a complication most states would not like. Moreover, most applicants are over age 18, the age at which GL doesn't apply in many states. Many states require a full driver's licence before issuing a learner permit for a motorcycle. (McKnight, pers. com. 2001).

Although the above perspective has merit, it is of some interest that 14 to 17 year olds accounted for 22% of the teen motorcycle drivers age 14-19 involved in fatal crashes and 18% of the teen driver deaths in the United States in 1999. Thus, teens younger than 18 are operating motorcycles and contributing to the problem of teenage motorcycle crashes.

It has also been suggested that since graduated licensing is a concept developed for novice drivers of passenger vehicles, it may not be appropriate to apply the concept to novice motorcyclists (Smith, NHTSA, pers. com. 2001).

According to the MSF, California, Maryland and South Dakota are the only states that actually apply the graduated licensing concept to motorcyclists. Other road and motorcycle safety experts contacted could not identify additional states with graduated licensing programs for motorcyclists. However, as mentioned above, several other U.S. states apply restrictions in the learner motorcycle permit stage and a few restrict novice drivers in some or all age groups to operating on specific motorcycle sizes. Such programs are conceptually similar to graduated licensing. The graduated licensing programs in California, Maryland and South Dakota and the restrictive practices in other U.S. states are described below.

2.2.1 California *(July 1998)*

INSTRUCTION PERMIT

Entry Requirements:

- 15 ½ years of age
- completed driver education and driver training

- Pass vision test and test on traffic laws and signs, and a test on motorcycle driving rules

Features:

- Mandatory 6 months
- No passengers
- Driving during daylight hours only
- No driving on freeways

PROVISIONAL LICENCE

Entry Requirements:

- Motorcycle skill test
- Persons under 21 years of age complete an approved motorcycle rider training course (skill test waived)
- At least 16 years of age

Features:

- Mandatory 12 months
- First 6 months with no passengers under 20
- No driving between midnight and 5 a.m.
- Earlier licence control actions for at-fault accidents/convictions

Exit Requirements:

- None

2.2.2 Maryland *(July 1999)*

Maryland introduced a "Rookie" driver graduated licensing system in July 1999 that applies to both novice drivers of passenger vehicles and motorcycles. The requirements and features for novice motorcyclists are described below.

LEARNER'S PERMIT

Entry Requirements:

- At least 15 years, 9 months
- Enrolled in approved rider education program
- Pass vision test and knowledge test

Features:

- Mandatory 4 months
- Suspension
- No passengers
- Times of day
- Certified 40 hours of supervised "practice" driving

PROVISIONAL LICENCE

Entry Requirements:

- At least 16 years, 1 month
- Successful completion of motorcycle safety course
- Successful completion of driver education
- Pass skills test either in traffic or on a course

Features:

- Mandatory 18 months
- If under 18 years of age, no unsupervised driving between midnight and 5 am
- Driver improvement actions if convicted of a moving violation

Exit Requirements:

- At least 17 years, 7 months

2.2.3 South Dakota *(January 1999)*

INSTRUCTION PERMIT

Entry Requirements:

- At least 14 years of age
- Pass vision, knowledge (car/truck), and motorcycle knowledge test

Features:

- Mandatory 180 days if under 18 years of age (90 days if successful completion of approved driver education; 30 days if successfully completed approved driver education course and motorcycle safety course)
- Supervision by licensed motorcycle operator who is driving another motorcycle
- No passengers

RESTRICTED MINORS PERMIT

Entry Requirements:

- Between 14 and 18 years of age
- Pass motorcycle driving test

Features:

- Driving only during the hours of 6 a.m. to 8 p.m.

Exit Requirements:

- Upon attaining age 18, permit converts to Operator's Licence

2.2.4 Summary

All three U.S. graduated licensing programs include a learner or instruction permit and an intermediate stage.

Level 1: Learner stage. All learner stages have entry requirements – e.g., tests and mandated education/training – and minimum holding periods – 6 months in California, 4 months in Maryland, and 180 days in South Dakota. The minimum entry age ranges from 14 years in South Dakota to 15 years, nine months in Maryland. Although rider training and/or driver education are required in all three states, only South Dakota reduces the minimum holding period for successful completion of courses. Maryland also requires 40 hours of certified driving practice. Restrictions in this stage typically include no passengers, no night driving, and supervision.

Level 2: Intermediate stage. The intermediate stages in all three states also have entry requirements – e.g., on-road skills tests and rider training – and minimum holding periods – 12 months in California, 18 months in Maryland, and until 18 in South Dakota. In California, during the first 6 months of the 12-month minimum holding period, no passengers under 20 are allowed on the motorcycle. All three states have some form of night driving restriction in this stage. Exit requirements are age-based in Maryland and South Dakota. None of these states have an advanced, on-road test to exit their graduated licensing program and obtain a full motorcycle operator licence.

2.3 Restrictive Practices in Other U.S. States

Most states (48) require beginners to obtain a learner's permit to operate a motorcycle. The three jurisdictions that do not are Louisiana, Arkansas, and Alabama. All jurisdictions, except New Hampshire and Washington, require knowledge and skill tests to obtain a learner permit. In Wisconsin, beginners under 18 must be enrolled in a rider course before obtaining a permit. In Pennsylvania, beginners must pass vision and knowledge tests if they do not hold a driver's licence.

The restrictions applied in the learner stage in each state are shown in Table 2 on page 25 and summarized on the next page. To be comprehensive, this table also includes

information on the three states with graduated licensing programs that were described in more detail in the previous section – California, Maryland, South Dakota. This information was taken from the Motorcycle Safety Foundation's "Cycle Safety Info: State Motorcycle Operator Licensing – 2000".

- Supervision (23 states)
- Helmet usage (35 states)
- Restrict learners to certain roadways (14 states)
- Restrict time of day for operation (28 states)
- Zero BAC (4 states – California, Illinois, West Virginia, and Wisconsin)
- No passengers (33 states)
- Restrict learners to riding within the state or shorter distances (3 states – Connecticut, Vermont, Missouri)
- Restrict cycle size of learner's motorcycles (8 states)
- Eye protection (10 states)

In Pennsylvania, learner motorcyclists must also hold the permit for 6 months and complete 50 hours of adult-supervised on-road "practice".

The minimum licensing age without rider education varies from a low of 14 years in three states -- Alabama, Oklahoma, South Dakota -- to a high of 21 years in 3 states – California, Florida, Idaho. The minimum age for licensing if the applicant takes driver education ranges from 13 years in New Mexico to 17 years in New Jersey. Rider training is required for all applicants in Rhode Island and Maine, and for certain age groups in the following states:

- Under 16 – North Dakota
- Under 18 – Connecticut, Delaware, Illinois, Iowa, Maryland, Michigan, Minnesota, New Mexico, Ohio, Texas, Washington
- Under 21 – California, Florida, Idaho, Oregon

Almost all states (43) waive knowledge and/or skill tests for novices who successfully complete state-approved rider education.

Nine states also have "tiered" licensing programs that restrict some or all ages groups to operating on specific motorcycle sizes:

Table 2: Motorcyclist Learner Permits, US 2000

	Supervision	Helmets	Restricted Roadways	Times of Day	Zero BAC	No Passengers	Restricted Distances	Cycle Size Rest.	Eye Protect.
Alabama			NO LEARNER PERMIT SYSTEM						
Alaska	x	x							
Arizona			x	x					
Arkansas			NO LEARNER PERMIT SYSTEM						
California		x	x	x	y	x			
Colorado	x								
Connecticut		x	x	x		x	x		
Delaware		x	x	x		x		x	
Dist of Columbia	x	x							
Florida		x				x			
Georgia		x	x	x		x			
Hawaii				x		x			
Idaho		y	x	x		x			
Illinois	x			x	x			x	x
Indiana	y	x		x		x			
Iowa	x								
Kansas	x					x			
Kentucky		x							
Louisiana			NO LEARNER PERMIT SYSTEM						
Maine		x		x		x			
Maryland	x	x		x		x			
Massachusetts		x		x		x			x
Michigan	x	x		x		x			x
Minnesota		x	x	x		x			x
Mississippi	x	x							
Missouri		x		x		x	x	x	
Montana	x	y							
Nebraska	x	x							
Nevada	x	x	x	x		x			
New Hampshire		y		x		x			
New Jersey	x	x							x
New Mexico						x		x	
New York	x	x	x	x		z			x
North Carolina						x			
North Dakota		x		x		x		x	
Ohio		x	x	x		x			x
Oklahoma	x			y				y	
Oregon	x	x		x		x			
Pennsylvania	x			x		x			
Rhode Island	x		x			x			x
South Carolina		y							
South Dakota	x	y				x			
Tennessee		x	x	x		x		y	
Texas	x							y	
Utah		y	x	x		x			
Vermont				x		x	x		
Virginia	x	x	x	x		x			
Washington		x				x			
West Virginia		x		x	x	x			x
Wisconsin	x	x			x	x			x
Wyoming		y							

y Certain age groups only
z No passengers except supervisor
States with graduated licensing programs are in bold text

- Alabama – under 16 restricted to 150cc
- Oklahoma – under 16 restricted to 250cc or less
- Texas – under 16 restricted to under 250cc
- Illinois – under 18 restricted to under 150cc unless completed rider training
- Montana – 15 ½ to 16 restricted 250cc or less
- New Mexico – under 15 restricted to 100cc or less
- North Dakota – under 16 restricted to 250cc
- Washington – three tier system based on engine size
- Tennessee – under 16 restricted to 650cc or less; under 15 restricted to 125cc or less

3.0 The Safety Impact of Graduated Licensing and Restrictive Practices

Until recently, few jurisdictions had graduated licensing programs for novice drivers of passenger vehicles, so only a small number of evaluations have been completed to date. Even fewer jurisdictions had extended such programs to novice drivers of motorcycles (see previous section) and only the one introduced in New Zealand in 1987 has been formally evaluated. Evidence on the safety benefits of recent programs targeted at motorcyclists in Canada and the United States is therefore lacking.

To overcome this situation, original data analyses were performed to determine if the implementation of graduated licensing programs in Ontario, Nova Scotia, and Quebec were closely followed by reductions in motorcycle crashes. Similar analyses were not possible in other provinces that have recently implemented programs – i.e., adequate crash data will not be available for several years.

Other U.S. states that apply restrictions, principally on learner motorcyclists, have not evaluated their programs. However, among the various restrictions that have been put in place, the one based on engine size/power has received careful scrutiny to determine its' safety impact, particularly in jurisdictions outside North America. Research has also examined the safety effectiveness of rider education and training programs in North America and elsewhere.

This section initially reviews the scientific evidence from published studies on the safety impact of graduated licensing for drivers of passenger vehicles and motorcycles. It then describes the results of original data analyses to provide some indication of the potential impact of the programs in Ontario, Nova Scotia, and Quebec. Finally, the section considers what is known about the safety benefits of specific restrictive practices applied to novice motorcyclists such as engine size/power limits, and about the merits of rider

education and training. Indirect evidence on the value of other restrictive practices – e.g., supervision, no passengers, daylight driving only – are also reviewed.

3.1 Evaluations of Graduated Driver Licensing Programs

This section summarizes the results of published research that has evaluated the impact of graduated licensing programs for drivers of passenger vehicles and riders of motorcycles.

3.1.1 Impact of Graduated Licensing Programs for Passenger Vehicles

Formal evaluations in New Zealand, Florida, Ontario, and Nova Scotia have shown that graduated licensing is associated with significant reductions in collisions. Preliminary findings from ongoing evaluations in Michigan, Kentucky, North Carolina and California also suggest that graduated licensing is effective. Key findings from these evaluations are summarized below.

- In New Zealand, a substantial 7% reduction in-car crash injuries was found among 15-19 year olds (Langley et al. 1996).
- In Florida, a 9% reduction in the casualty involvement rate among 15-17 year old drivers was found (Ulmer et al. 2000).
- In Ontario, a 31% reduction in the collision rate of novice drivers was observed (Boase and Tasca 1998).
- In Nova Scotia, there was a 37% reduction in collisions among 16 year old drivers during the first three years of the program (Mayhew et al. 2000).
- In Kentucky, a 34% reduction in per-driver collision rates among 16 year olds was found (Kentucky Transportation Center 1999).
- In Michigan, there was a 32% reduction in the per-driver casualty rate among 16 year olds (Michigan Department of State 1999).
- In North Carolina, a 26% reduction in crashes among 16 year old drivers was reported (Foss 1999).

- In California, there was a 20% reduction in fatal and injury at-fault crashes among 16 year old drivers (Automobile Club 2000).

All of the studies conducted to date have shown positive benefits of graduated licensing programs for drivers of passenger vehicles. Crash reductions have ranged from 7% (in New Zealand) to 37% (in Nova Scotia).

3.1.2 Impact of Graduated Licensing Programs for Novice Motorcyclists

Although several graduated licensing programs for motorcyclists are now in place, only one has been formally evaluated. In 1987, New Zealand introduced a graduated licensing system that applied to both novice drivers of passenger vehicles and motorcycles. The requirements and conditions for novice motorcyclists are described below.

New Zealand

LEARNER LICENCE

Entry Requirements:

- Minimum age of 15 years
- Pass vision and theory test
- Pass basic, off-road, handling skill test

Features:

- Minimum 6 months (or 3 months with approved rider education)
- BAC below 30 mg%
- No riding between 10 p.m. and 5 a.m.
- Maximum speed limit of 70 km/h
- "L" plate
- No passengers
- 250cc engine capacity restriction

RESTRICTED LICENCE

Entry Requirements:

- Pass practical driving test

Features:

- Minimum 18 months (or 9 months with approved course)
- BAC below 30 mg%
- No riding between 10 p.m. and 5 a.m.
- Passenger may be carried in a side car
- 250cc engine capacity limit

Exit Requirements:

- None

The features of the graduated licensing program in New Zealand are very comparable to several of the programs recently implemented in North America (see section 2.0). This is not surprising because some jurisdictions modeled their programs on the New Zealand one.

Reeder et al. (1999) evaluated the impact of the New Zealand program on motorcycle traffic crashes that resulted in serious injury. Time series analysis revealed that the introduction of the program was followed by a significant 22% reduction in motorcycle traffic crash injuries for 15-19 year olds – the main target group for the program. No statistically significant changes were observed for two comparison groups of older motorcyclists – those aged 20-24 and 25 and over, who were not covered by the program.

According to Reeder et al., "an examination of vehicle registration and driver licensure data suggests that the reduction in injury crashes may, largely, be attributable to an overall reduction of exposure to motorcycle riding." The extent to which reductions in motorcycling were a result of the implementation of the program itself or a result of other unrelated factors – e.g., an economic downturn which may have reduced travel, particularly among youth; a decline in the popularity of motorcycling among young drivers – was not explored by the authors.

3.2 Original Data Analyses on the Impact of Graduated Licensing Programs

Jurisdictions in Canada and the United States that have recently introduced graduated licensing for novice motorcyclists have not evaluated the safety impact of their programs. Some indication of the safety value of programs adopted in Canada, however, can be

derived from an examination of annual motorcycle crash data. This is possible with those programs introduced several years ago – Ontario (1994), Nova Scotia (1994) and Quebec (1997). Relevant crash data are not available for those jurisdictions that more recently introduced graduated driver licensing for novice motorcyclists.

This section examines the extent to which the implementation of programs in Ontario, Nova Scotia and Quebec were closely followed by reductions in the number of crashes involving young motorcyclists – i.e., those most likely to be novice riders and, consequently, most affected by the program. For all three jurisdictions, annual data, from 1990 to 1998, on the number of motorcycle riders and passengers age 15 to 19 killed and injured in road crashes were available from published reports. Annual police-reported collision data were also available for Ontario and Nova Scotia for this 9-year period. The analysis focused on the number of 16 and 17 year old motorcycle drivers involved in collisions – i.e., fatal, injury and property damage crashes. SAAQ provided summary data tables on the number of 16-19 year old motorcycle drivers involved in injury collisions from 1996 to 1999 in Quebec, so these data were also used to examine the safety impact of the program in that province.

To control for unknown factors, the crash trends of internal and external control groups were used. The internal control group involved motorcyclists age 25 to 54 (or age 25 and over), who would be largely unaffected by the graduated licensing program. The external controls came from the rest of Canada that did not introduce graduated licensing during the same periods as Ontario, Nova Scotia and Quebec. Collision data from British Columbia were not included in the rest of Canada totals because of major changes in police-reporting practices in that province over the study period.

3.2.1 Safety Impact in Ontario

Figure 1 shows the number of motorcycle riders and passengers killed and injured in road crashes in Ontario from 1990 to 1998. The lower curve presents data for deaths and injuries among 15-19 year olds; the upper curve presents data for the comparison group of 25-54 year olds. The vertical line indicates the year (1994) in which graduated licensing was introduced in Ontario.

Figure 1:
Number of Motorcycle Riders and Passengers Killed and Injured in Ontario 1990-1998

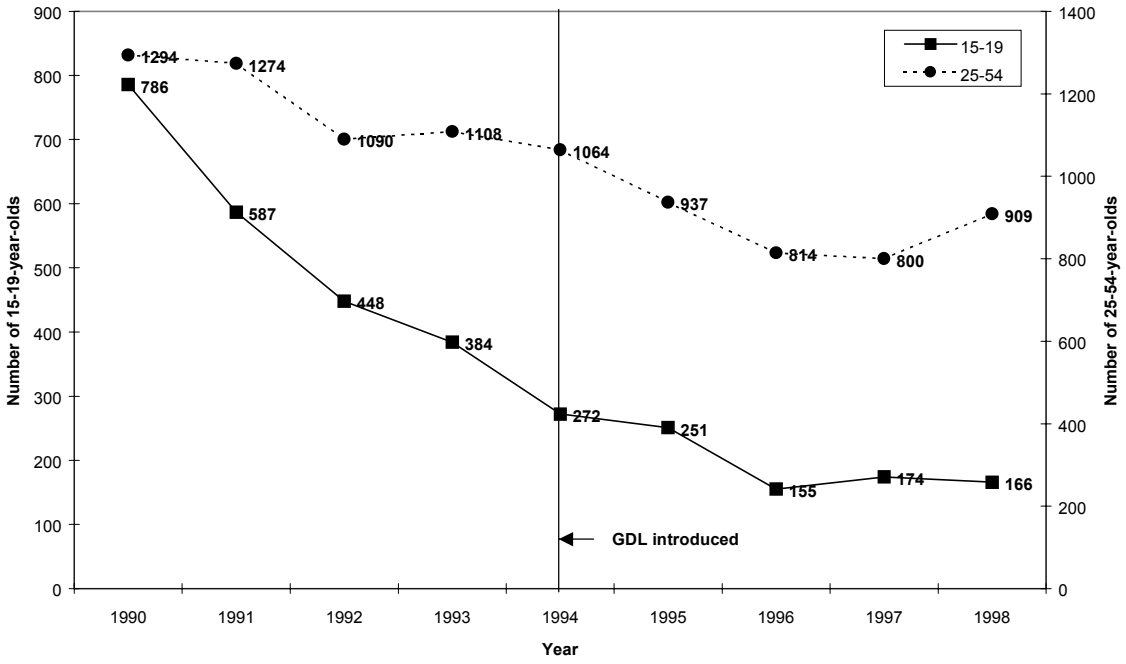
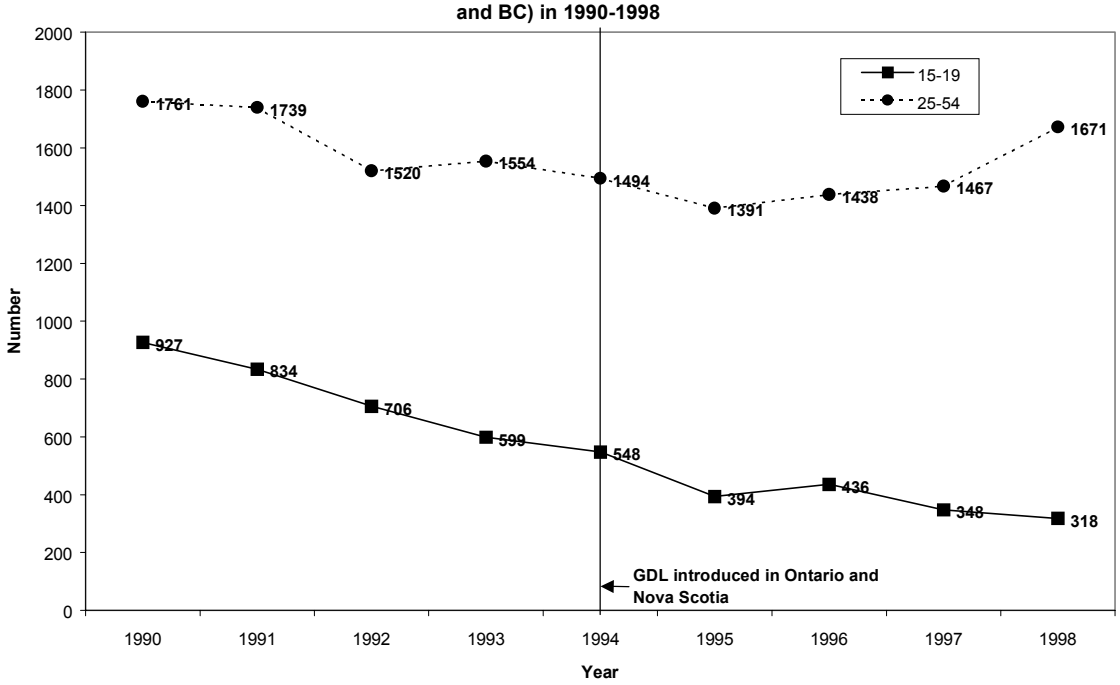


Figure 2:
Number of Motorcycle Riders and Passengers Killed and Injured in Canada (excluding ON, NS and BC) in 1990-1998



A simple comparison of the number of deaths and injuries prior to the implementation of the program in 1994 with the number of casualties after the program was introduced would seem to suggest that there was a positive impact. That is, there were 384 teen motorcyclists (drivers and passengers) killed and injured in 1993; this figure dropped to 251 in 1995 – a 35% decline in deaths and injuries. However, deaths and injuries among the comparison group, not affected by the program, also declined from 1,108 in 1993, to 937 in 1995 – a 15% decline. It is tempting to ascribe the greater net decline among teens to the graduated licensing program. This possibility is strengthened even further by the finding that 15-19 year old motorcycle casualties continued to decline to 1998 but casualties among 25-54 year old motorcyclists actually increased from 1997 to 1998.

This conclusion is, however, not tenable because the short-term changes described above appear to be more a function of general, longer-term downward trends in motorcycle casualties than the impact of graduated licensing.

To illustrate, Figure 2 shows trends in motorcycle casualties in the rest of Canada. Using the same comparisons as those for Ontario, it can be shown that casualties among teen motorcyclists dropped by 34% from 1993 to 1995, whereas those among the older group dropped by only 10%. This differential is comparable to what occurred in Ontario but cannot be attributable to the graduated licensing program since none was introduced in these other control provinces. The changes must be accounted for by factors other than graduated licensing.

As is evident in both Figures 1 and 2, the trends in casualties among teen motorcyclists have been declining since 1990. Indeed, the decline appears even more pronounced prior to, than after, 1994.

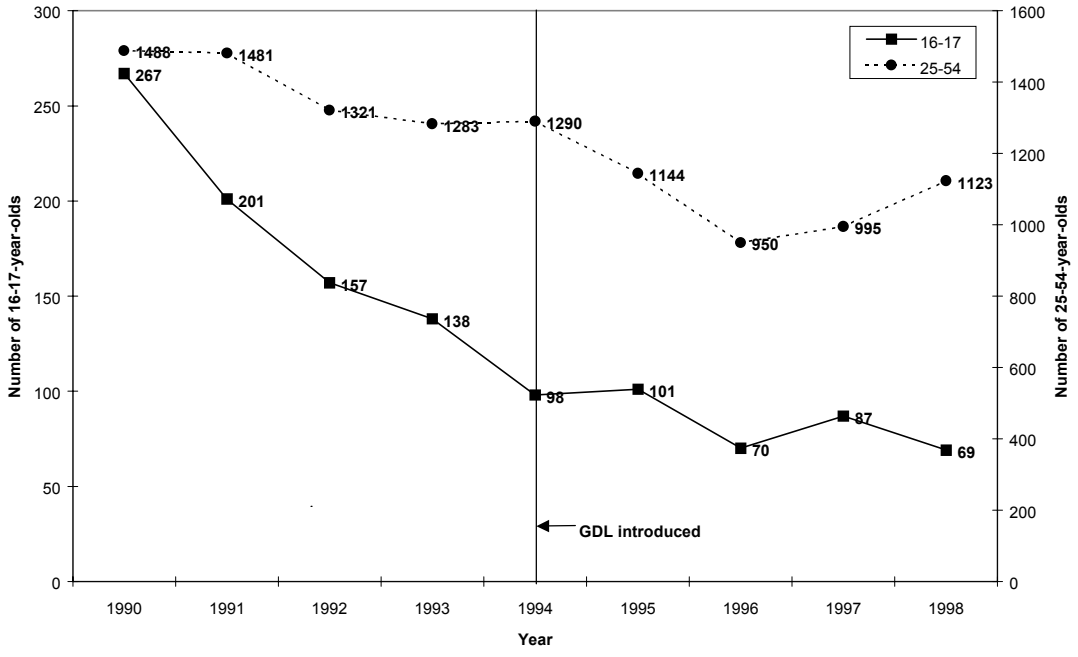
The above comparisons focused on teens aged 15-19 because this is the age group used in the published source documents. In the post-program period, however, some 15-19 year olds would have been licensed under the old system – e.g., someone licensed at age 16 in 1993 under the old system who crashed at age 18 in 1995, the post-program period. In fact, it would take several years before all 15-19 year olds were licensed under the new program. Accordingly, the above comparisons are confounded

to some extent because in the years immediately following the implementation of the program not all 15-19 year old motorcyclists were licensed under the new program. Focusing exclusively on 16 and 17 year olds can rectify this situation– i.e., a higher proportion of them would be under the new system in the post-program period.

The above comparisons also focused on motorcycle drivers and passengers killed and injured in road crashes. This is only one indicator of the motorcycle crash problem and it is possible that it is insensitive to the impact of the program. Examining data on the number of teen motorcycle drivers involved in collisions provides another test of the effectiveness of the program. The focus here is on all drivers whether they are injured or not.

Accordingly, Figure 3 shows the number of motorcycle drivers aged 16-17 and age 25-54 involved in collisions in Ontario over the study period. The pattern of results is comparable to that reported above – i.e., a downward trend in collisions, more pronounced for 16 and 17 year olds, that began several years before the implementation of the program and continued thereafter. Thus, the reductions in collisions among teen drivers in the post-program period may be attributable to whatever factors were responsible for the pre-existing downward trend and not the result of the implementation of the graduated driver licensing program.

Figure 3:
Number of Motorcycle Drivers Involved in Collisions in Ontario 1990-1998

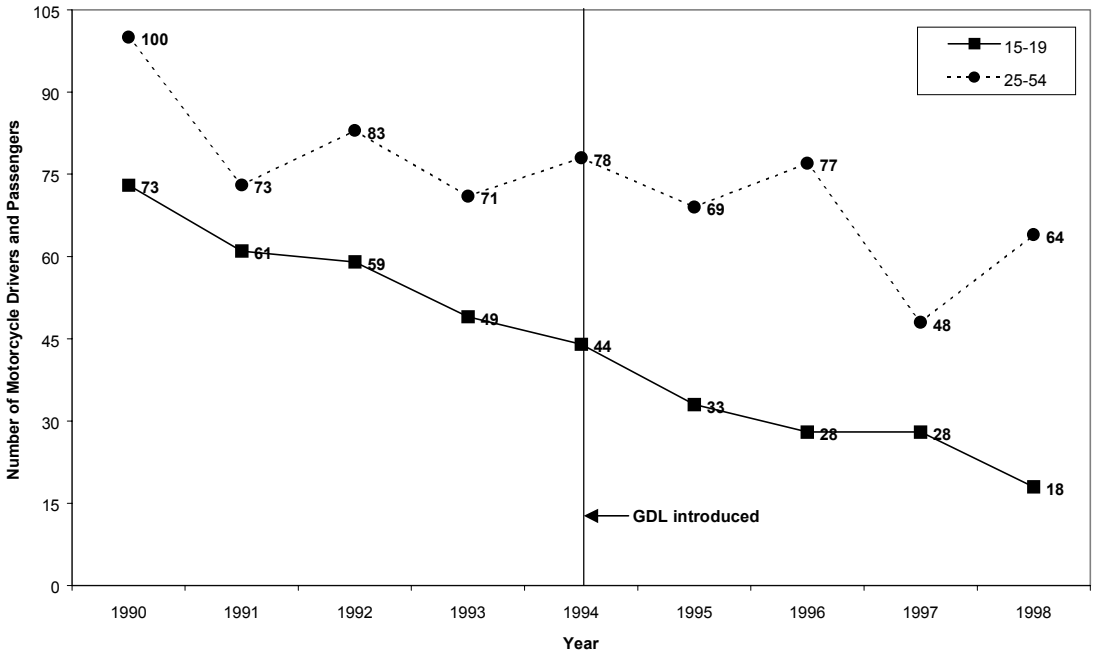


More refined and sophisticated analysis – e.g., interrupted time series analysis of monthly collision data – are required to control for, or eliminate, the powerful influence of the pre-existing downward trend and, thereby, determine if the implementation of the program actually had a measurable impact on collisions. Such an analysis was beyond the scope of this project.

3.2.2 Safety Impact in Nova Scotia

Figure 4 shows the number of motorcycle drivers and passengers killed and injured in road crashes in Nova Scotia from 1990 to 1998. The lower curve presents data for deaths and injuries among 15-19 year olds; the upper curve presents data for the comparison group of 25-54 year olds. The vertical line indicates the year (1994) in which graduated licensing was introduced in Nova Scotia.

Figure 4:
Number of Motorcycle Riders and Passengers Killed and Injured in Nova Scotia 1990-1998



The pattern of results in Nova Scotia is very comparable to that found in Ontario. The number of deaths and injuries among 15-19 year old motorcyclists was much lower after than before the implementation of the program in 1994. However, there is no reason to

believe this decline was attributable to the graduated licensing program because there has been a long-term downward trend in motorcycle casualties dating back to 1990, several years before the program was put in place. This trend may have simply continued into the post-program period. It appears that whatever factors that were responsible for the downward trends in motorcycle casualties in Ontario as well as in the rest of Canada (see Figure 2) were favorably influencing teen motorcyclist casualties in Nova Scotia as well. Accordingly, the reductions in motorcyclist casualties among 15-19 year olds in Nova Scotia after 1994 were likely a continuation of the pre-existing downward trends and did not result from the implementation of the graduated licensing program.

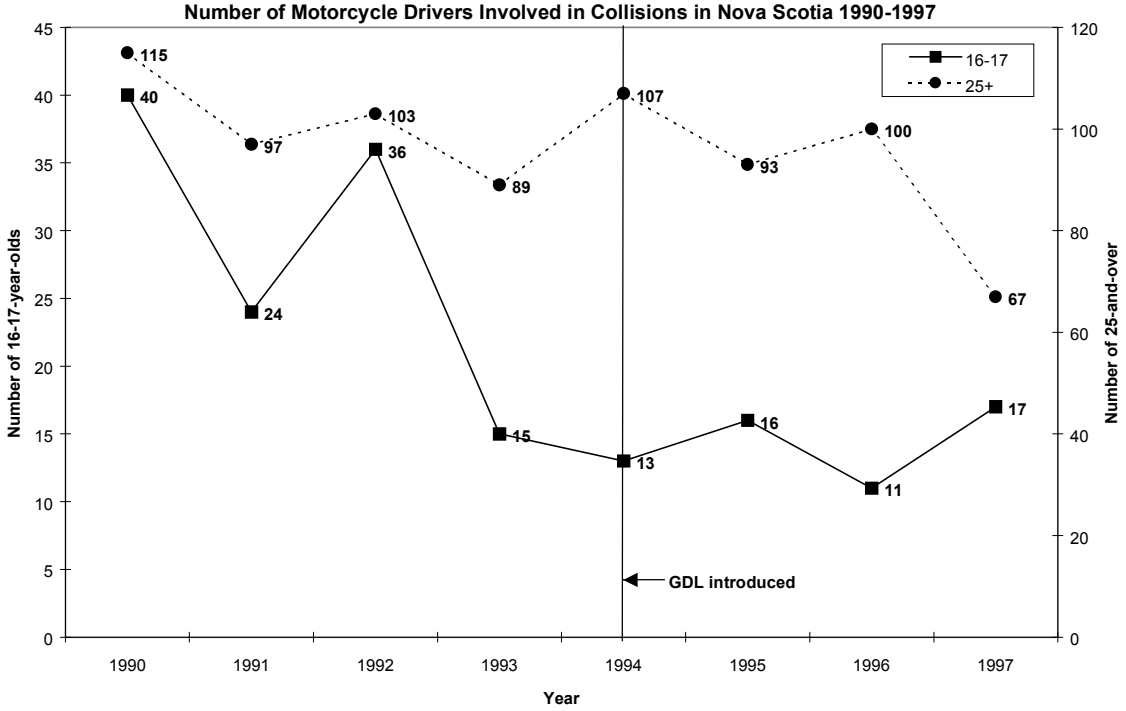
A slightly different picture emerges from Figure 5, which shows the number of motorcycle drivers aged 16-17 and age 25 and over involved in collisions in Nova Scotia over the study period. Collisions involving 16-17 year old drivers generally declined in the period before the program was implemented in 1994; following the program, the number of their collisions remained largely unchanged. By contrast, since the program was put in place, collisions among the comparison group have declined. These results suggest the graduated driver licensing program had no impact on the intended target group – 16 and 17 year old drivers. However, the small number of collisions annually among teen drivers means that the trends are unstable – i.e., subject to random fluctuations on an annual basis – and, consequently, conclusions based on these numbers should be treated cautiously.

At the very least, the safety impact of graduated licensing for young motorcyclists is not apparent from the above comparisons. Further investigation is required to "factor out" or "control for" the pre-existing downward trend to determine if reductions are still apparent and, if so, whether the program accounted for them.

3.2.3 Safety Impact in Quebec

Figure 6 shows the number of motorcycle riders and passengers killed and injured in road crashes in Quebec from 1990 to 1998. The lower curve presents data for deaths

Figure 5:
Number of Motorcycle Drivers Involved in Collisions in Nova Scotia 1990-1997



and injuries among 15-19 year olds; the upper curve presents data for the comparison group of 25-54 year olds. The vertical line indicates the year (1997) in which graduated licensing was introduced in Quebec.

Similar to the findings in Ontario and Nova Scotia, there was a decrease in casualties among teen motorcyclists in Quebec from the year before to the year after program implementation – 251 casualties in 1996 compared to 133 casualties in 1998, a 47% reduction. Once again, however, teen motorcyclist casualties have been declining in Quebec since 1990, suggesting, as was the case in Ontario and Nova Scotia, that factors other than the graduated driver licensing accounted for the decreases in the post-program period.

The above conclusion is not as tenable in Quebec as it was in Ontario and Nova Scotia for several reasons. Motorcyclist casualties among the comparison group of 25-54 year olds actually increased from the year before to the year after the program was implemented – from 1,029 casualties in 1996 to 1,177 casualties in 1998, a 14% increase. The fact that casualties among teens dropped by 47% from 1996 to 1998, whereas those among the older comparison group increased by 14%, might suggest a positive impact of the program.

Figure 6:
Number of Motorcycle Riders and Passengers Killed and Injured in Québec 1990-1998

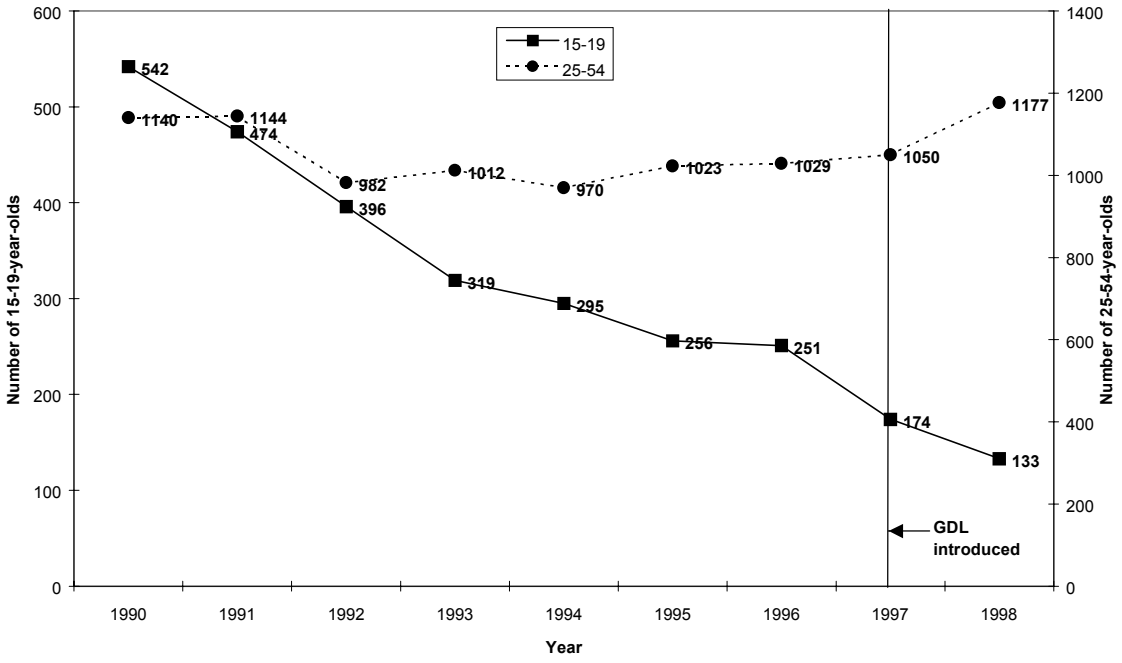
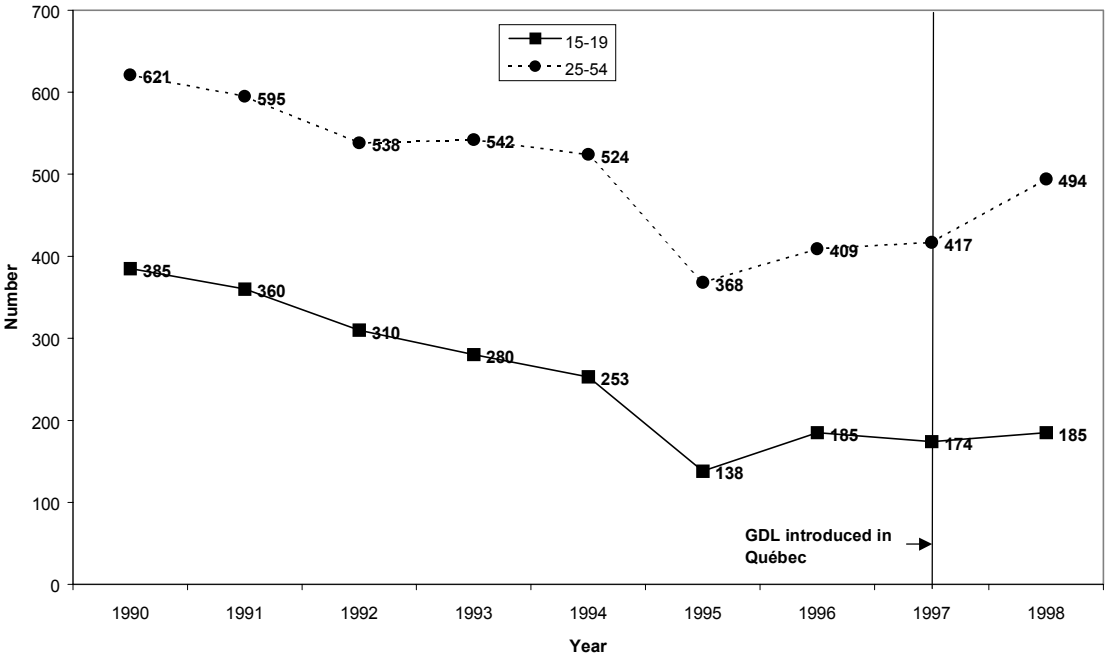


Figure 7:
Number of Motorcycle Riders and Passengers Killed and Injured in Canada (excluding ON, NS, PQ, BC) in 1990-1998



This possibility is strengthened even further by the trends in motorcycle casualties in the rest of Canada shown in Figure 7. As can be seen, casualties among teen motorcyclists remained unchanged from 1996 to 1998 – 185 casualties in both years. This trend contrasts with the dramatic reduction (47%) in teen motorcyclist casualties from 1996 to 1998 in Quebec. These results suggest that the graduated driver licensing program may have contributed to the reductions in teen motorcyclist casualties after 1997. However, the influence of the general, longer-term downward trend in motorcyclist deaths and injuries among 15-19 year olds since 1990 cannot be completely ruled out.

Further evidence that the program might have had a positive impact was provided by the SAAQ and is displayed in Table 3. This table shows the number of motorcycle drivers in various age groups involved in injury collisions per 10,000 motorcycle owners in periods before and after the implementation of the graduated driver licensing program. The advantage of these comparisons is that the data are based on injury crash **rates** and, therefore, control for changes in the population of motorcyclists. This is important because much of the pre-existing, longer, downward trend in collisions among teen motorcyclists experienced in Quebec (or in the other provinces) could be attributable to corresponding decreases in the number of teen motorcyclists. And in this regard, there were 1,322 motorcycle owners age 16-19 in 1995-1996 (annual average) compared to only 881 in 1999. At issue is the extent to which this 33% drop in the number of motorcycle owners accounted for all of the reductions in collisions among teen drivers. If this were the case, the collision rate among teen drivers should remain the same in the pre- and post-program periods. Such is decidedly not the case as shown in Table 3.

Table 3

Number of Motorcycle Drivers Involved in Injury Collisions per 10,000 Motorcycle Owners

Driver Age	*Pre-GDL 1995-96 (average)*	*Post-GDL 1997-98 (average)*	*1999*	*Percent change 1995-96 vs. 1999*
16-19	1411	1162	1090	-23%*
20-24	653	642	634	-3%**
25-34	262	254	258	-2%**
35 and over	139	133	132	-5%**

* statistically significant, p<.05
** not statistically significant

As can be seen, among 16-19 year old drivers, there was a significant 23% decrease in their injury collision rate from 1995-1996 (pre-GDL period) to 1999 (post-GDL period). By contrast, the small decreases -- 5% or less -- among the older age groups of motorcycle drivers were not statistically significant.

These findings suggest that the graduated licensing program in Quebec has been effective in reducing collisions among teen motorcyclists. However, even though changes in motorcycle ownership have been controlled in the analysis, it is still possible that other factors responsible for the pre-existing downward trend in teen injury collisions, accounted for some, or possibly all, of the reductions observed in the post-program period. Further evaluation is needed to determine if the program had an independent and positive impact on motorcycle collisions involving teen drivers.

3.2.4 Summary

These preliminary analyses suggest that the graduated licensing program in Quebec has been associated with a significant reduction in collisions among the primary target group. The programs in Ontario and Nova Scotia, however, have not been found to reduce collisions. It is possible that different findings would have emerged for Ontario and Nova Scotia if their collision data were standardized to take into account changes in the teen motorcycling population. This was possible for Quebec but not for Ontario and Nova Scotia.

All three jurisdictions implemented graduated driver licensing programs during a period in which motorcycle collisions were falling dramatically, particularly among teens. It is possible that the factors responsible for the general, pre-existing downward trends in motorcycle collisions exerted such a powerful influence that it masked any additional beneficial safety impact of the graduated licensing programs. More comprehensive and sensitive analyses – e.g., time series analysis of monthly collision data -- are required to determine the extent to which this is the case.

It is also possible that the Quebec program is in fact effective and the Ontario and Nova Scotia programs are not. A review of the features of each program reveals major differences in how graduated driver licensing has been applied (see section 2.1).

Certain features of the Quebec program that are absent in Ontario and Nova Scotia may have contributed to the effectiveness of the Quebec program. For example, riding under supervision is required in Quebec but not in Ontario and Nova Scotia. Research has shown that relatively few novice drivers crash when supervised and this situation likely extends to novice motorcyclists. The mandatory holding period for a learner's licence is also considerably longer in Quebec (minimum 12 months when the program was first implemented) than in Ontario (only 60 days) and Nova Scotia (6 months). Other differences in program characteristics may also be important in accounting for the divergent findings.

3.3 Safety Impact of Restrictive Measures Applied to Novice Motorcyclists

A previous section (2.3) identified a range of restrictions and conditions applied to novice motorcycles as part of graduated driver licensing programs or included in the licensing procedures for learners in several U.S. states – i.e., those on a learner permit or instruction permit. These included knowledge and performance-based skill tests (off-and on-road), supervision at all times, certified riding practice, no passengers, road and/or speed restrictions, daylight only riding, driver education/rider training, and engine size/power limits. Among these requirements and restrictions, the safety benefits of applying limits on the engine size or power of the motorcycle driven by novices and of taking rider education/training have received the most research attention. The safety value of other restrictions, applied alone, or in combination – e.g., zero BAC, night curfews, supervision, no passengers -- have not been as well researched for novice motorcycle drivers. However, indirect evidence is available on several of these conditions and restrictions.

Research on each restrictive practice is discussed below. Based on the strength of the scientific evidence, the merits of including the restriction in a graduated driver licensing program for novice motorcyclist is considered. Where direct evidence is lacking, the indirect evidence and the rationale for the measure are considered as a basis to support or reject it.

3.3.1 Knowledge and Performance–based Skill Tests

In the United States, as early as 1968, a major motorcycle accident investigation (Reiss et al. 1968) identified motorcycle operator testing and licensing as the most promising means to achieve long-term cost-effective accident reductions. Such tests are designed to ensure that people who ride motorcycles (and other vehicle types) are competent and that they are aware of safe riding practices and road law. Basically, the test(s) sets the minimum standards for "safe" riding and provides a means to ascertain if someone has achieved that standard and can, therefore, graduate from the learner stage.

Although motorcycle operator tests are commonplace, few jurisdictions have determined whether or not such requirements are effective. Mayhew and Simpson (1989) reported that in the few jurisdictions in which studies have been undertaken, the introduction of improved testing and licensing schemes are generally associated with reductions in casualties among novice motorcyclists. However, they observed that these reductions appear to occur not because of a higher proficiency among those exposed to the new tests and procedures, but because new, more complex schemes, for whatever reasons, deter people from becoming motorcyclists. Thus, most of the safety benefits that have been recorded are the results of reduced exposure to risk.

Early evaluations of the effectiveness of skill tests for novice drivers of passenger vehicles have largely produced conflicting findings. In a review of these studies, MacDonald (1987) as well as McPherson and McKnight (1981) concluded that "the road test lacked sufficient predictive validity to support their use as a screening device in determining who will be permitted to drive".

A more recent investigation of the Driving Performance Evaluation Road Test, a much more reliable test than the standard drive test in California, failed to find any reduction in accident involvement or traffic law violations resulting from the implementation of the program (Gebers, et al. 1998).

By contrast, unlike most other driver performance measures or road tests, a computerized test developed and used in Victoria, Australia – the HPT – was able to predict those novice drivers likely to be involved in casualty crashes (Congdon 1999).

The above findings suggest that the rationale for knowledge and performance-based skill testing are compelling but traditional tests have largely failed to discriminate adequately between safe and unsafe drivers. The need is to improve the quality and safety potential of the tests, for example, by focusing more on hazard perception, and this is in fact the direction that has been pursued recently in several jurisdictions – e.g., British Columbia, New Zealand, and New South Wales, Australia (Mayhew et al. in preparation).

3.3.2 Supervision

Research shows that supervised driving is a relatively safe activity – i.e., few novice car drivers crash under supervision (Williams et al. 1997; Mayhew et al. 2001). Accordingly, although supervising a novice on a motorcycle is more difficult than supervising a novice driving a passenger vehicle, supervision should also benefit novice motorcyclists. Since balance and coordination is more difficult with a passenger, the supervisor should be on another motorcycle or following closely in a passenger vehicle.

3.3.3 Engine Size/Power Limits

In 1984 and again in 1989, Mayhew and Simpson conducted comprehensive, critical reviews of the scientific literature on the relationship between engine size/power and collision involvement. They concluded that there was a lack of evidence to support the introduction of motorcycle engine size/power limitations for novice motorcycle drivers. More recently, Van Honk et al. (1997), in a further review of the scientific literature, reached a similar conclusion.

Langley et al. (2000), in a recent New Zealand study, examined whether the risk of an injury increases with increasing capacity of the motorcycle. The authors overcame important limitations of previous research in this area by controlling for exposure and other potential confounding factors – e.g., age, socioeconomic status, absence of a licence, car driving experience. Their analysis did not demonstrate a strong relationship between increasing cubic capacity and increasing risk of crashing. Thus, the conclusion reached by Mayhew and Simpson over a decade ago remains valid today – despite

numerous studies and the growing popularity of applying engine size/power restrictions, the scientific evidence to support such restrictions is still lacking.

3.3.4 Zero or Low BAC Limits

There is evidence that the effects of alcohol consumption on motorcycle riding are far more dramatic than its effects on car driving (Haworth et al. 1994). This is not surprising given that motorcycle riding demands greater co-ordination, balance and concentration than that required to drive a passenger vehicle (Haworth and Schulze 1996). Even low levels of alcohol may be especially problematic for young novice riders (and drivers) because it likely interacts with their inexperience and youthfulness to create even greater crash risk. And, in this regard, Mayhew and Simpson (1990) reported that low concentrations of alcohol increase the crash risk of young people more so than older ones.

Evaluations of those countries that have included lower alcohol limits as part of their licensing system generally show that the limits are effective in reducing collisions (Mayhew and Simpson 1990). Research has also shown that low BAC limits reduce the likelihood of collision among young drivers (Simpson and Mayhew 1992; Mayhew and Simpson 1999). The zero BAC limit included in the Ontario graduated driver licensing program was found to reduce alcohol-related crashes among novice drivers by 27% (Boase and Tasca 1998). Accordingly, a zero BAC limit applied during the first few months or years of riding appears warranted.

3.3.5 No Passengers

A passenger on the motorcycle increases the total number of persons at risk and the severity of injury to the motorcycle operator (Social Development Committee 1991). A passenger also makes balancing the motorcycle more difficult and a teenage passenger may distract the novice operator and/or encourage the young rider to take risks. Research shows that unsupervised driving with teenage passengers increases crash risk compared with driving alone (Preusser et al. 1998). Accordingly, a no-passenger restriction, at least in the critical learning stage, makes sense.

3.3.6 Daylight Driving Only

Night driving is more difficult and more dangerous than driving during daylight hours for riders and drivers of all ages. Research has established that night driving is especially risky for young beginners and that night curfews are effective in reducing crashes (Williams and Preusser 1997; Preusser et al. 1984). Night curfews may even have a beneficial impact on collisions in non-restricted hours (McKnight et al. 1993).

Research has also shown that the earlier the hour the night restriction is applied, the greater the safety benefit (Williams and Mayhew 1999). Accordingly, restricting the riding of beginning motorcyclists to daylight hours deserves serious consideration.

3.3.7 Driver/Rider Education/Training

Many graduated licensing programs for novice motorcyclists mandate driver education and/or rider training; some allow novices to graduate sooner if they successfully complete driver education/rider training – i.e., a "time discount". Research has shown that traditional rider/driver education/training programs have not reduced crashes. In this regard, Mayhew and Simpson (1996) recently reviewed the evaluation research in three countries – Canada, the United States and Europe – and found no compelling evidence that rider training is associated with reductions in collisions. These findings are consistent with much of the evidence on the effectiveness of formal instruction (Mayhew and Simpson 1999).

Even worse, at least one recent study suggests that "time discounts" for novice drivers of passenger vehicles may actually have a detrimental safety impact – formally trained novices who get the "time discount" have a much higher crash rate than untrained novices who do not (Boase and Tasca 1999). Although the reasons for this finding are unclear, the fact that the "time discount" allows trained drivers to graduate sooner than untrained novices from the learner stage, thereby exposing them to more crash risk, likely contributes to their higher crash rates.

Given these findings, there is certainly no justification for "time discounts". However, jurisdictions can encourage or even mandate driver education/rider training because it can be a superior way to learn basic riding skills and it can contribute to the beginner's on-road experience – i.e., practice – but they should not allow novices to graduate sooner if they take driver education/rider training.

3.3.8 Certified Practice

A few jurisdictions now require parents to certify that a certain number of hours – e.g., 40 to 50 hours – have been driven under supervision. Although the safety benefits of certified driving practice have not been evaluated, requiring a minimum amount of practice hours is consistent with the rationale of graduated licensing – i.e., allow the novice to gain driving experience under low risk conditions.

3.3.9 Road Limits

Certain types of roads, because of characteristics such as high traffic volume, mixed vehicle types, and multiple lanes are more demanding than others. For inexperienced riders and drivers, who are still learning basic vehicle handling skills, such roads can prove overwhelming and extremely hazardous. Although road restrictions are commonly used for new motorcyclists, the effects of prohibiting novice riders (or drivers) from traveling on certain road types has not been evaluated until recently. In the evaluation of the Ontario graduated driver licensing program, Boase and Tasca (1998) examined the safety impact of the highway restriction on novice drivers of passenger vehicles – i.e., no driving on expressways or freeways. They found that this restriction reduced collisions of novice drivers on those highways by 61%.

3.3.10 Speed Limits

This restriction can simply limit the maximum speed at which a novice can drive, or it can specify the type of road on which a novice can drive – i.e., prohibited from driving in excess of 80 km/hr; no driving on road with posted speed limits of 80 km/hr. The rationale for limiting speed is to encourage the novice to gain experience at speeds

which provide a greater margin of safety (Drummond and Torpey 1984). An additional benefit is that if a collision does occur it will be at a lower speed and result in less severe injuries.

Although this restriction has been applied to novice motorcyclists, no research has been conducted to assess its safety impact.

3.3.11 Advanced Exit Tests

A number of jurisdictions have introduced or are considering advanced "exit" on-road or computer-based skill tests for novice drivers of motorcycles and passenger vehicles, which is administered prior to leaving the graduated licence program to ensure the novice has actually driven and acquired the needed experience and skills. These advanced tests typically assess higher order safe driving skills, such as, hazard perception.

The use of advanced testing is so recent that evidence of its effectiveness in reducing crashes of young drivers of passenger vehicles or motorcycles is not yet available. However, a hazard perception computer test initially developed as an exit test but used as an entry test to move from a learner stage to an intermediate stage in Victoria, Australia, has been found to be predictive of safe driving (Congdon 1999).
As observed by Mayhew and Simpson (1999), advanced testing may hold promise for predicting collision risk among young drivers and could, therefore, serve as a means of determining who requires remedial action or, in the case of graduated licensing, who needs to be in the system longer.

3.4 Summary

Evaluations to date have all shown that graduated licensing programs for novice drivers of passenger vehicles reduce collisions among the intended target audience. There is also some evidence that graduated licensing programs for novice motorcyclists have been effective in reducing collisions in New Zealand and, possibly, in Quebec. However, the results of original data analyses provide no evidence that the programs in Ontario and Nova Scotia reduced collisions. Further research is needed to determine the safety

impact of graduated driver licensing in these provinces as well as in other jurisdictions in North America that have recently introduced programs for novice motorcyclists. This is important because the existing programs as well as those that are planned include different features and conditions, so in the absence of further evaluations it is difficult to identify the features that will be most effective in reducing collisions among novice motorcyclists.

Although few evaluations have been conducted on the safety impact of graduated licensing for novice motorcyclists, there is evidence that some of the specific restrictions or conditions typically applied in a graduated driver licensing program do reduce crashes. In cases where no studies have been conducted, there is at least a strong rationale that the restriction should have safety benefits.

The features that can be supported based on the scientific evidence or, in the absence of research, on logical grounds include: improved tests, including exit testing; supervision; improved rider education/training; certified practice; daylight driving only; zero or low BAC limits; no passengers; and road and/or speed restrictions.

The scientific evidence is not compelling for “time discounts” for rider education/training and for engine size/power limitations.

4.0 Discussion and Recommendations

Graduated licensing is potentially more constructive than other licensing approaches because it provides the opportunity for beginners to gain experience and proficiency under low risk conditions. It also addresses age-related factors by minimizing the opportunities for young beginners to engage in risky behaviours or encounter risky situations – e.g., through the use of night curfews, low or zero BAC, and lengthy periods of supervised driving. As well, such programs insulate young beginners from risky conditions, and in doing so, allow the beneficial effects of increased maturity to be realized by delaying full licensure. Graduated licensing is also attractive because it can be tailored to address unique economic, social, geographic and political conditions within a jurisdiction.

Graduated licensing makes sense for both novice drivers of passenger vehicles and motorcycles because the factors that give rise to their elevated crash risk are the same – i.e., "inexperience" for all novices and for youth, "immaturity" as well. This fact has been recognized in at least six jurisdictions in Canada – Ontario, Nova Scotia, Quebec, British Columbia, Newfoundland and the Yukon – that have already adopted graduated driver licensing programs for both novice drivers of passenger vehicles and motorcycles. As stated in the British Columbia motorcycle rider handbook, RoadSense for Riders":

> As a new rider you are part of a high-risk group. (p. 1)
>
> To reduce the number of crashes among new drivers and riders, ICBC introduced the Graduated Licensing Program (GLP). GLP is designed to help new drivers and riders gain experience gradually under conditions that expose them to less risk. (p. 147; ICBC 2000)

For the same reasons, three jurisdictions – Alberta, Saskatchewan and Manitoba -- are now considering the implementation of graduated driver licensing for both these high risk, novice driver groups. In the United States, graduated licensing for novice motorcyclists has not been as popular as it has been for passenger vehicle drivers. However, three U.S. states – California, Maryland and South Dakota – have recently

adopted programs for novice motorcyclists and many other U.S. states apply one or more restrictions to learner motorcyclists.

Current and planned graduated licensing systems for novice motorcycle riders can and do vary substantially in their operational features – e.g., in terms of the restrictions selected, how they are applied and to whom, over what period of time, what sanctions are applied to violators, and so on. This flexibility is an attractive feature of graduated licensing, because it can be tailored to the particular needs of a jurisdiction. However, in designing a graduated licensing system, it is critical that its features are true to the basic prevention principle of providing opportunities to obtain driving experience under conditions that minimize exposure to risk. In addition, the elements of the system should be based, to the extent possible, on scientific evidence and proven effectiveness.

In this regard, there is evidence that the programs adopted in New Zealand and, possibly, in Quebec have been effective in reducing collisions. Moreover, research suggests that specific restrictions typically included in programs that are currently in place or under consideration reduce collisions – e.g., supervision at all times, daylight driving only, zero BAC limits. The scientific evidence is considerably less compelling for engine size/power limits. Although research is lacking for other restrictions, such as certified driving practice, these measures are consistent with the rationale of graduated driver licensing.

Until further evaluations and studies are undertaken and completed, it is difficult to identify the optimal requirements and features of a graduated driver licensing program for novice motorcyclists. However, reviews of programs, both in place and planned (see section 2.0), as well as of the scientific evidence on key features (see section 3.0) provide at least some guidance for structuring an optimal program.

At a minimum, a model program would involve three stages:

- The first is an extended learners stage, during which driving would be permitted only under the supervision of a fully licensed motorcyclist, following closely on another motorcycle or in a passenger vehicle. During this critical “learning to ride” stage, the novice would be required to have a minimum number of hours of

practice, certified by their supervisor and/or parent. Riding under supervision would be allowed only during daylight hours (sunrise to sunset) because the novice must be seen by the supervisor – i.e., supervision on another motorcycle or in a passenger vehicle may be difficult and impractical during hours of darkness. Since supervision may also be impractical on certain types of roads – e.g., expressways – and at higher speeds, road and/or speed restrictions would apply. No passengers would be permitted and the learner would need to display an "L" plate on the motorcycle.

- The intermediate stage would permit unsupervised driving but only in less risky situations such as during the day. During riskier night hours – e.g., from 9:00 pm or 10:00 pm until 5:00 am – and when riding on certain types of higher speed roads – e.g., freeways, roads with posted speed limits over 90 km/hr -- the novice would be required to have a fully qualified motorcyclist as a supervisor seated behind them, or in a sidecar. In fact, during the first few months on this stage, only a fully licensed motorcyclist would be allowed as a passenger to supervise the novices' initial experiences carrying someone else on the motorcycle. In addition, during these first few months or, for the full intermediate period, passengers under 20 would not be allowed. After the first few months, other passengers would be allowed during unsupervised riding – e.g., during the day and on lower speed roads. The novice would be required to display an "N" plate on the motorcycle in this intermediate stage.
- The third and final stage, a full privilege licence, would become available when conditions of the first two stages have been met – e.g., a crash- and violation-free record; passing initial off-road (e.g., balance) test and on-road skills tests and later even a more advanced exit test that focuses on higher-order skills such as hazard perception.

Performance-based, "entry" and advanced skills tests ensure the novice has achieved the minimum standards of safe riding and serve as incentives for them to acquire the skills and experience needed to pass these tests.

During both the learner and intermediate stages, a zero BAC limit – i.e., zero tolerance – would apply. The supervisor would also be restricted to a low or zero BAC.

Safe motorcycling demands balance, coordination, concentration and sound judgment under different road conditions and situations, all critical skills lacking in beginning riders. The most efficient way to acquire these skills is through a formal rider education and training program that focuses on rider skills as well as rider motivations and attitudes. Such programs also provide a means to practice and gain needed riding experience in low risk situations, under the supervision of a qualified instructor. Accordingly, integrating rider education and training could potentially enhance the effectiveness of graduated driver licensing. However, efforts should be made to improve the form and content of existing education and training programs because the safety benefits of the programs that have been evaluated to date remain unproven. Although the benefits of these improvements have not been established, they may offer promise and can only be evaluated if implemented. Until proven, training should not receive special status, such as being allowed to substitute for time in the system. Successful completion of rider education and training should not be recognized through a "time discount, which is a feature of graduated licensing programs in Canada that has been shown to have negative safety consequences.

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Motorcycle and Scooter Safety Forum

Motorcycle Protective Clothing

Liz de Rome
LdeR Consulting
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The George Institute for International Health

Perth 2009

LDR
Research and Planning Consultants

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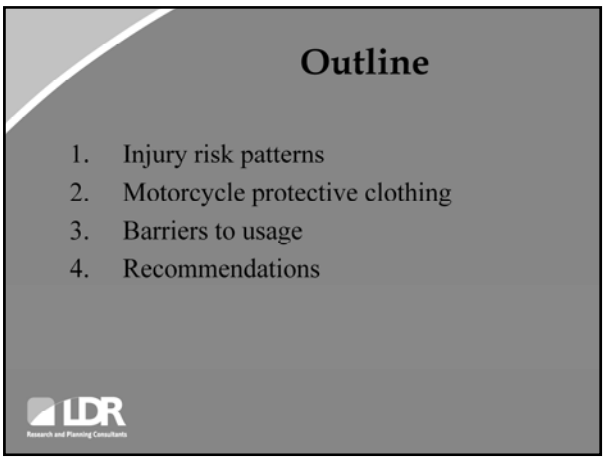
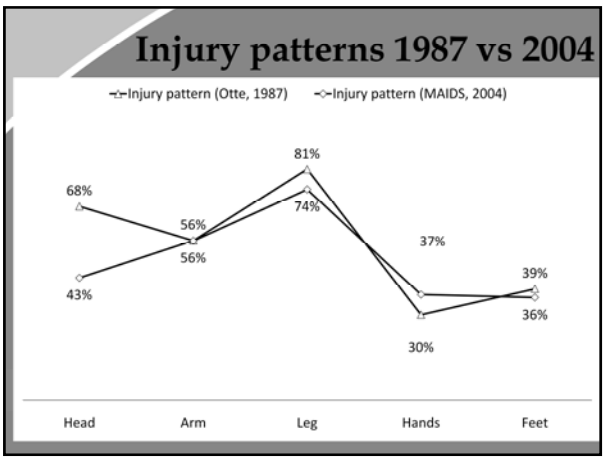


Patterns of injury risk and usage of protective clothing,

What are the barriers to usage

What could we do?



This graph shows the proportion of riders with injuries to each part of their body. These are taken from two large scale studies of motorcycle crash injuries in Europe published in 1987 and 2004.

There is almost no difference in the injury patterns reported, except for the head. The 1987 data included a substantial proportion not wearing helmets, and I have used the data for whose without helmets. Inclusion of the helmeted riders brought the head injury percentage down to 48% in the 1987 study.

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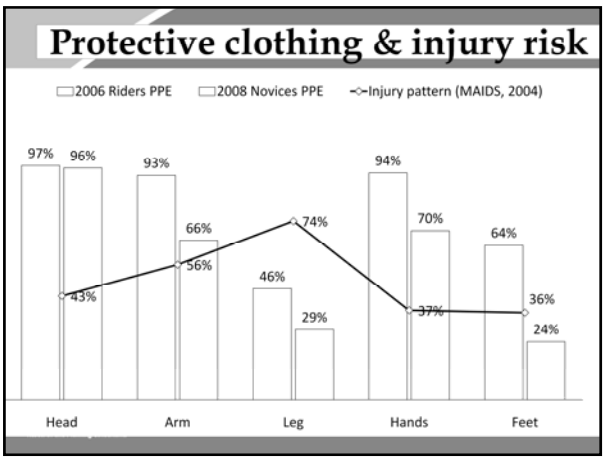

These are the results of a couple of surveys of riders in NSW. The columns show the proportion who always wear motorcycle protective clothing by part of their body. The line is taken from the previous slide, showing injury patterns from MAIDS (2004).

The Riders (2006) survey were generally experienced riders, >50% were motorcycle clubs members, they read motorcycle magazines and accessed motorcycle websites. They were relatively well informed about motorcycling matters.

Novices were surveyed when they attended for their Provisional rider licence test. So had less than one year, and many had just 3 months riding experience.

Both groups were least likely to protect their legs and feet, but we know from the previous slide that the legs are the part of the body most likely to be injured in a crash.

People sometimes assume, there is no point in protecting legs, because clothing can't prevent a fracture. In the MAIDS study, of the 74% with leg injuries, the majority had only soft tissue injuries, less than half had fractures.

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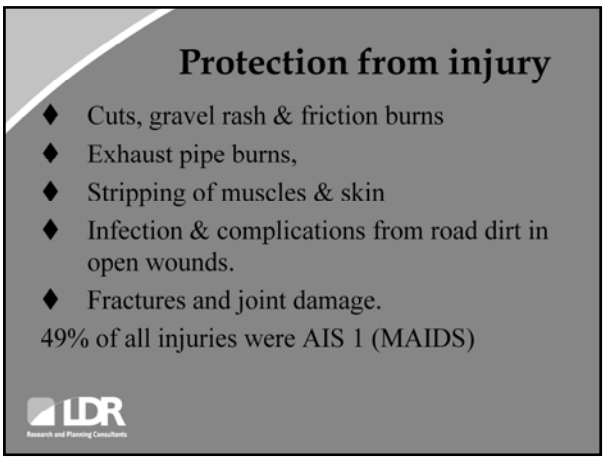
de Rome, L., Ivers, R., Harworth, N., Heritier, S (2009), The Novice Rider Study: Final report. Unpublished report to the NRMA. For further information contact the author, Liz de Rome at lderome@george.org.au.

MAIDS (2004), Motorcycle Accident In-Depth Study: In-depth investigations of accidents involving powered two wheelers. Final Report 1.1. Association of European Motorcycle Manufacturers (ACEM), Brussels.



Effective protective clothing can prevent or reduce many soft tissue injuries.

Protective clothing can also reduce the risk of infection and complications by reducing the risk of open wounds

This is not a trivial benefit. Scarring and joint damage are a major cause of disability for motorcycle casualties.

One study found protected riders had 7 days less in hospital and 20 days earlier return to work (Schuller, 1986).

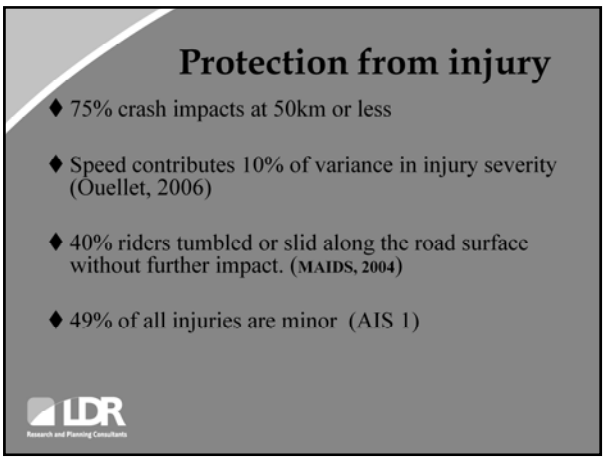
Soft tissue injuries amount to up to half of all the injuries suffered in motorcycle crashes (MAIDS, 2004).

For many riders, this type of injury is the only injury they suffer (MAIDS, 2004).

Reference:

MAIDS (2004), Motorcycle Accident In-Depth Study: In-depth investigations of accidents involving powered two wheelers. Final Report 1.1. Association of European Motorcycle Manufacturers (ACEM), Brussels.

Schuller, E., G. Beir, et al. (1986). Disability and impairment of protected and unprotected motorcycle riders. SAE International Congress and Exposition - Crash Injury Impairment and Disability : Long Term Effects, Detroit, MI, Warrendale, PA.



Protective clothing won't save you from being bent or crushed by another vehicle

Or from the impact of hitting a solid object, particularly not at high speed.

But, most motorcycle crashes are not high impact crashes.

The MAIDS study, found that 75% of crash impacts occur at speeds of 50 Km or less. (30 mph)

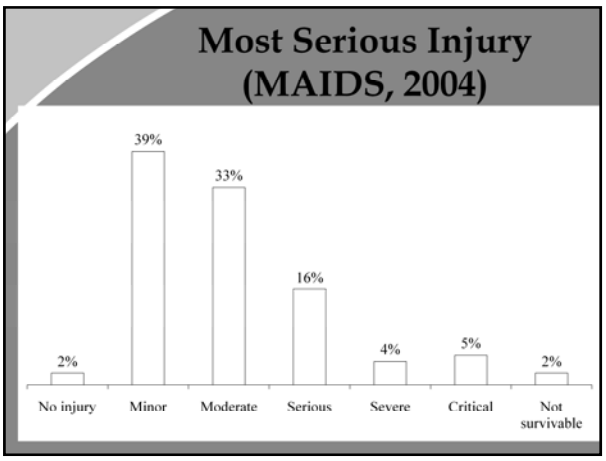
And speed contributes less than 10% of the variance in injury severity, object hit is more important. This does not mean that speed is not a serious issue for riders, just that you don't have to be going very fast to get hurt.

They also found, 40% of riders in a crash tumbled, rolled or slid along the road without further impact with another object.

It is these types of crashes where injuries are most likely to be reduced or prevented by appropriate clothing.

References:

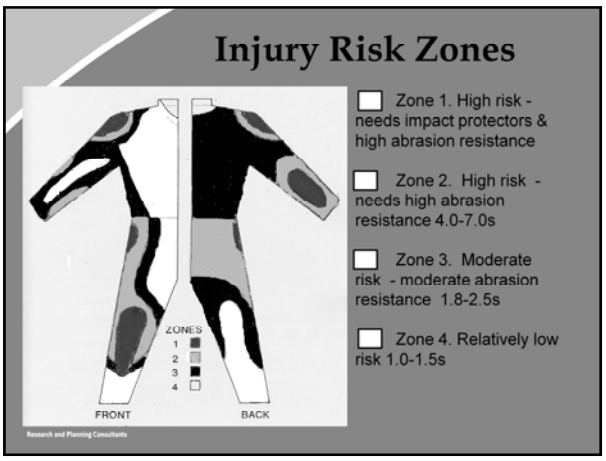
Ouellet & Kazantikul (2006) Motorcycle Rider Training and Collision Avoidance, presentation to the 2006 Human Factors, International Motorcycle Safety Conference, Motorcycle Safety Foundation, 26 March – 1 April, Long Beach, USA.



This table shows the severity of the most serious injury suffered by the riders in the MAIDS study.

You can see, the most serious injury suffered by 39% of the riders, was minor. Another 33% were rated as moderate.

Protective clothing can have a role in these types of crashes.



Different parts of the body have different injury risk levels in a crash.

The red zone needs impact protectors and high abrasion resistant materials. 4 -7 seconds

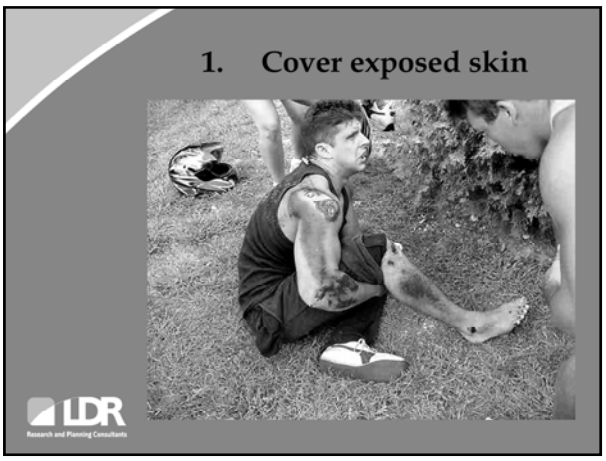
The green zone needs the same level of abrasion resistance, but not impact protectors.

The white zone – can be made of mesh or elasticised relatively low abrasion materials for comfort. Still needs to give at least 1 second abrasion resistance.

These zones were devised from analysis of the impact points and damage to 100 leather suites from crashes.

Reference:

Woods, R. I. (1996). Specification of motorcyclists' protective clothing designed to reduce road surface impact injuries. Performance of Protective Clothing. J. S. J. a. S. Z. Mansdorf. Philadelphia, American Society for Testing and Materials, ASTM STP 1237. Fifth Volume: 3-22.



The first principle is to cover all exposed skin.

With abrasion resistant materials, that will protect the rider’s skin as they slide across a road’s surface.

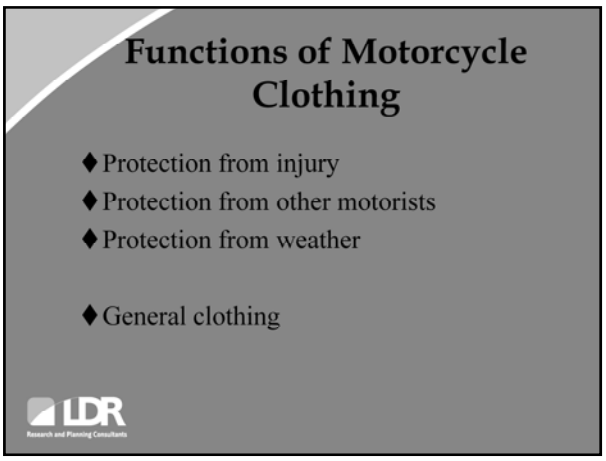
Impact protectors should be worn over all the joints and bony bits.

Impact protectors that comply with the European standard, are designed to limit the force of a blow at the point that bone may break, but it won't shatter.

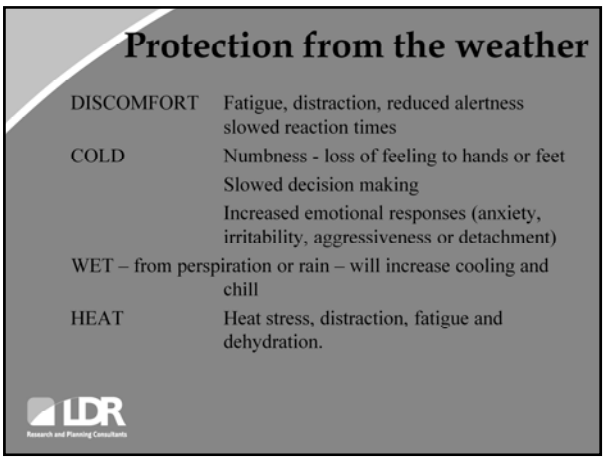
Clothing needs to fit closely so that is stays in place during the twisting and dragging forces of a crash.

The most common single failing in motorcycle clothing is the failure of seams and fastenings, which burst open on impact.

Riders need to look for multiple layers of stitching when they buy gear.



Part of the difficulties is that motorcycle clothing has to serve a number of different functions.



Protection from being cold, wet or too hot are also safety issues

By improving comfort, you reduce fatigue, distraction and dehydration.

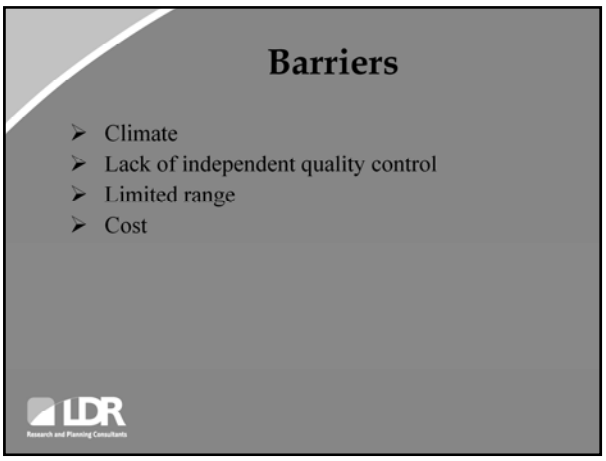
Being cold can result in loss of feeling to hands and feet, which interferes with operating the controls.

Lowering body core temperature can affect the brain – decision making or emotion reactions – irritable, detached.

Being wet is uncomfortable, but water conducts heat – so can increase wind chill. Not just rain, perspiration can also problem with chilling.

Heat is probably the issue that is hardest to deal with, for Australian riders and one we need to address urgently.

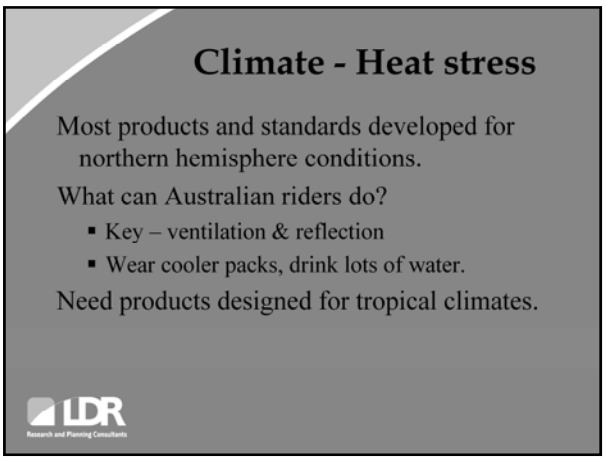
Ventilation and reflection of heat are the keys, but it is a difficult issue.



We know protective clothing can reduce injuries, but many riders do not fully protect their bodies. Why not?

What are the barriers?

- Climate - Few products designed for hot weather
- No independent evidence of product performance
- Limited range – particularly for women, commuters and scooter riders
- Cost



Most products have been developed for the northern hemisphere.

Helmets are a particular case in point. Helmet design is at complete odds with how to avoid heat stress.

For all gear, ventilation and reflection are the keys – vents, mesh panels, cooler packs.

But ventilation only works when moving, less value in slow traffic and vented helmets are noisy helmets.

We need products designed for tropical climates.

Some of the clothing sold to motorcyclists is just fashion without any serious protective function.

The only standards for motorcycle protective clothing are in Europe. There is a different standard and different number for each item of clothing.

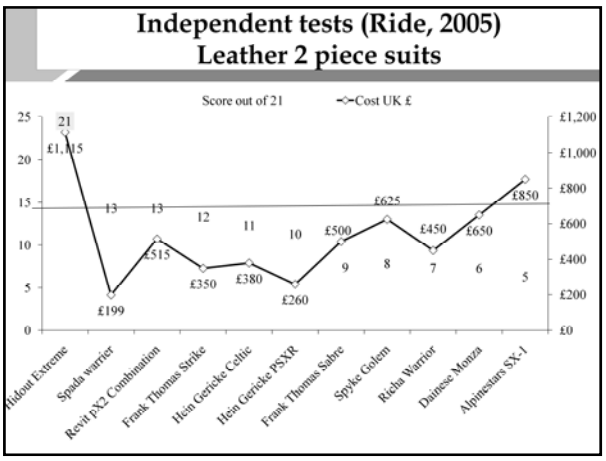
While the European intention was for manufacturers to submit their products to the tests in order to be able to sell them as protective clothing.

In fact few have complied, they tend to avoid marketing their products as 'protective' so that they don't have to go through the expensed of testing and requirement to comply with the standards. As a result the majority of European products sold here have not been tested and are not labelled as PPE.

The other major source of products sold here are from the USA where there are no standards.

The good thing is that the EU standards specify objective tests to assess performance.

These can be used to provide independent assessments for consumers.



Ride magazine in the UK, regularly publishes the results of such tests.

This shows the results for tests of 2-piece leathers published in 2005, only 1 of the 11 leather suits passed the tests.

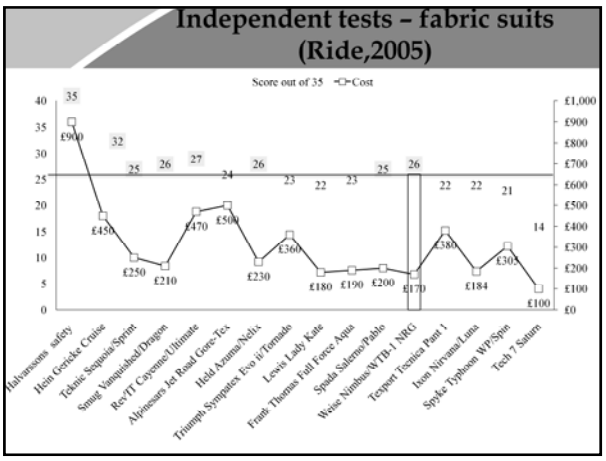
The columns show the score out of 21, 14 was the pass mark. The line shows the cost in UK pounds.

These are all well known brands. A rider buying any of these suits could not know, just by looking at them, how they might perform if put to the ultimate test.,

Neither cost or brand name are reliable indicators.

One of the cheapest leather suits scored second highest. Two very expensive suits, both very well known brands, came last.

http://www.motorcyclenews.com/Ride/Product-Tests/



These are the results on the same tests for 16 two piece fabric suits. The pass mark was 25 out of 35.

They did better than the leathers. but still only half, 8/16 passed.

And apart from the one high achiever, there is no relationships between cost and performance.

Tests of boots and gloves have found similar levels of poor performance. There are also products that perform well, but currently the only independent assessment available to riders is by reading Ride magazine.

The sad thing is that the test reports also indicate that relatively minor adjustments to production methods, such as seam design would over come many of the problems.

Reference:

http://www.motorcyclenews.com/Ride/Product-Tests/

Under the current system, riders have no certainty about the products they wear.

People tend to assume the more expensive or better known brands will be safer. But this is not the findings of the Ride tests.

My own research into motorcycle crashes and what riders were wearing, confirms that a lot of gear does perform vey well in crashes. But some doesn't.

The issue is that riders have no means for comparing different products.

A lot of information comes from the manufacturers – but how much of that is advertising spin and what is objective science?

There are websites and other sources of advice for riders on what to look for when buying gear, but this is putting responsibility onto riders to make decisions about what is essentially unknowable.

I have published information in a number of websites and reports. The Federal government have recently commissioned a product to be called the Good Gear Guide, which is intended to help riders choose the gear, but no one can tell just by looking at a product, how it will perform in the ultimate test of a crash. All we can say is how to identify the features of gear that is most likely to provide the necessary protection.

What riders wear is often driven by what is available. We are a small market on the world stage, most of our product is imported from the US and Europe.

The market is segmented into even smaller numbers:

In particular there is very little for women riders. Women cannot wear motorcycle clothing designed for men. This is not just a fashion issue, to be effective, it has to fit closely and particularly the impact protectors have to stay in place in a crash.

There is also insufficient product for use by commuters and for those for whom riding is general transport. Much of the gear is designed for recreational riding, where you go for a ride and then come home. Very little that is suitable for use as general clothing at a destination.

Gear promoted as providing injury protection tends to be designed for sports bike and off road riders, where injury risk is more accepted.

Gear is also very expensive, a scooter costs $3000, the most basic gear will cost half that again. And it is clothing – if you ride every day, one of each is not going to be enough. For example, kevlar lined jeans cost around $300.

At the least it should be recognised as safety gear and not attract GST, perhaps it should also be recognised for a rebate on medical insurance premiums.

Riders need:

Information about injury risks

Independent information products performance

Products suitable for Australian climate

Wider range of products suitable for different riding styles/ destinations.

Incentives e.g. insurance benefits for costs.

Industry needs:

Information, incentive and support to provide reliable protective gear.

Mandating usage of protective clothing cannot work, because we cannot define what would be appropriate product nor can we guarantee a supply of such products.

There is clothing not designed for motorcycling, that may well provide better protection than other clothing that is designed as motorcycle apparel but is fashion rather than protective.

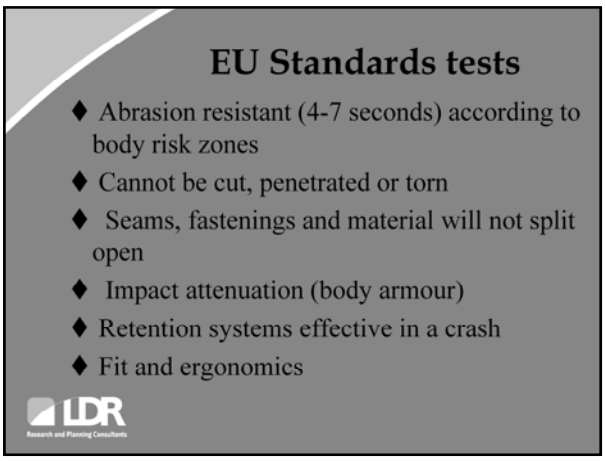
It is difficult for riders to tell the difference and impossible for enforcement purposes.

Product standards are good for riders and good for industry.

Set independent bench marks for performance.

Ensure that riders are able to make well informed decisions and that the products available are fit for purpose.

However, product standards would also be impossible to enforce in Australia, given the size of our market, because most of the products available internationally do not comply with any standards.



We can, however, make use of the tests developed for the European Standards and which replicate crash conditions.

These tests ensure that product are made from abrasion resistant material that will last when being dragged against the road surface. The requirements vary according to the part of the body. The highest risk areas need between 4 and 7 seconds.

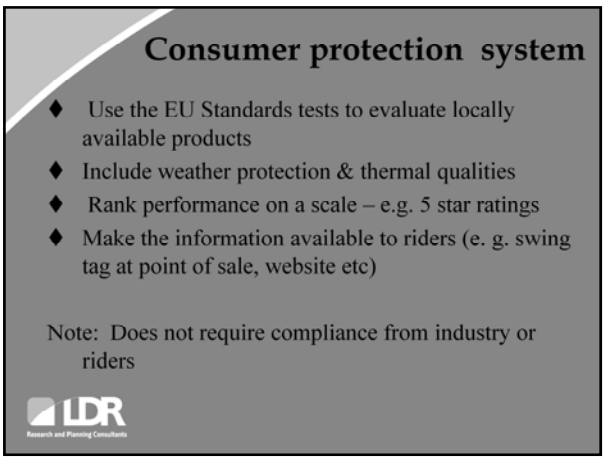
(note: Good leather might last up to 10 seconds but your average denim jeans offer 0.6 of one second)

The tests are to ensure that:

- The material cannot be cut, penetrated or torn by sharp objects in a crash.
- The seams, fastenings and the material itself, will not split or burst open on impact with the road.

- There are impact protectors over key joints, to spread the force of the impact at a less damaging rate.

- It will stay on and in place during a crash.



Mandatory standards will not work, we have seen that in Europe

But we can learn and benefit from that experience:

We can devise a consumer protection system, that will provide the information and incentives to encourage usage and improve the quality of available products. This could operate the way (NCAP) the New Car Assessment Program, assess cars – which has led to substantial improvement in the safety performance of cars.

We can devise a product performance assessment system, which is based on the EU standards tests.

But includes assessment of factors relevant to comfort such as weather and heat protection.

The system would be consumer oriented, to enable riders to make informed purchasing decisions.

And will provide industry with the incentive to provide those types of products.

I have been working with the Motorcycle Council of NSW, on ways to achieve this for some years. A number of government agencies have expressed interest and in the last couple of years, together with Narelle Haworth, we wrote a report for VicRoads on how a star rating system might be devised. A list of research projects and reports is attached.


THE GOOD Gear GUIDE
for Motorcycle & Scooter Riders
THANK YOU FOR YOUR ATTENTION
LDR
Research and Planning Consultants

2000 - Standards Australia, Motorcycle Protective Clothing; Guidelines for Manufacturing (Victoria)

2003 –MCC/MAA funded review of motorcycle protective clothing and development of MCC website (NSW) (reference de Rome, L., Stanford, G. & Wood, B. (2003). Motorcycle Protective Clothing. Road Safety Research, Policing and Education Conference,. Sydney

2004 – ACC NZ Ride for Ever website. http://www.rideforever.co.nz/gear_up/choose.html (by Liz de Rome).

2004 –MAA/ RTA advertisements promoting use of protective clothing (NSW)

2005 - MCC / MAA Industry Seminar on MC Protective Clothing (NSW) Reference: All papers and presentations are available at: http://www.roadsafety.mccofnsw.org.au/a/109.html

2005 – FCAI/ MCC /Australian accessories industry working party on the development of an industry based system (National) Report available at http://www.roadsafety.mccofnsw.org.au/a/109.html

2006 - VicRoads report on options for a star rating system. Haworth, de Rome, Varnsverry & Rowden (2006) Motorcycle Protective Clothing: Stage 1 Review of literature and development of a safety 'star rating' system. (RSD-0299 Report to VicRoads.

2007 – TAC website and advertisements promoting usage of protective clothing (Victoria)

2007 – The Novice Rider Survey, a survey of novice riders to identify the factors associated with the usage and non-usage of protective clothing by novice riders. Chief investigator. Liz de Rome, Funded by NRMA Motoring Services.

2008 – The Gear Study: a 12 month study of injured and uninjured riders in motorcycle crashes in the ACT to establish the contribution of protective clothing to the reduction or prevention of injury. Chief investigator. Liz de Rome, Funded by Swann Insurance Australia.

2009 - The Good Gear Guide, a pocket guide to protective clothing for riders. Written by Liz de Rome, an initiative of the Australian Motorcycle Council through the Motorcycle Safety Consultative Committee and funded by the Department of Infrastructure, Transport, Regional Development and Local Government.

Contact: liz@lderconsulting.com.au

Motorcycle protective clothing: Guidelines for manufacturing

Standards Australia document published in December 2000

Four "end use categories"

A Strong enough for racing

B Strong enough for sports road riding

C Strong enough for commuting

D Not strong enough to offer crash protection

- not mandatory
- no labelling
- apply only to clothing (not gloves, impact protectors and boots).

LDR
Research and Planning Consultants

THE INJURY REDUCTION BENEFITS OF

MOTORCYCLE PROTECTIVE CLOTHING

Liz de Rome
LdeR Consulting,

Sydney, Australia

NTSB

MOTORCYCLE SAFETY FORUM

SEPTEMBER 12 & 13TH, 2006

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The injury reduction benefits of motorcycle protective clothing

Liz de Rome
LdeR Consulting
Sydney, Australia

1. Abstract

An Australian survey of riders indicates that, while most riders fully protect their head and upper body, they are less likely to wear motorcycle pants or boots. This is despite long established patterns of injury risk confirming that the legs are the part of the body most likely to be injured in a motorcycle crash. Although protective clothing cannot prevent injuries in a high impact crash, most motorcycle crashes do not occur at high speed. There is now evidence that perhaps half of all motorcycle injuries are relatively minor soft tissue injuries, which could be reduced or prevented by the use of effective protective clothing. Well designed motorcycle clothing may also reduce the risk of crashes related to fatigue and distraction caused by heat, cold or wet stress and discomfort.

The essential features of effective protective clothing are well established and there are mandatory standards in Europe for any clothing purporting to provide injury protection. The standards provide manufacturers with a single bench mark and objective tests that can verify the protective performance of their products. The need for such standards is demonstrated by independent consumer evaluations applying the standards tests, which have revealed serious levels of failure in many of the products available in the European market.

If the use of protective clothing is to be encouraged, road safety authorities and the motorcycle accessories industry need to devise a means of assuring riders that products will provide the expected benefits. The motorcycle industry operates in an international market and the adoption of the European Standards as international standards could provide an effective means to ensure such products are fit for the intended purpose.

2. Introduction

For the purpose of this discussion protective clothing for motorcyclists is taken to include gloves, boots, a long sleeved jacket and pants, or one piece suit, made of leather or other fabric with high abrasion and tear resistance. Most items, these days will also include some impact protectors to absorb or distribute force at specific impact points. Our discussion does not include helmets because they are mandatory in Australia and usage is very widely accepted.

Motorcyclist clothing is required to serve a number of different purposes, these include to:

1. Prevent or minimise injury in the case of a crash,
2. Protect from the elements – wind, rain, cold and heat,
3. Draw the attention of other motorists (conspicuity),
4. Make a desired fashion statement/ be appropriate for general wear.

Our focus is on protection from injury in a crash, although comfort and conspicuity are also safety issues for motorcyclists.

Comfort in terms of protection from the elements is important in reducing fatigue,

distraction and dehydration and in this sense it may prevent crashes. The challenge for manufacturers is to provide protection from injury, as well as from the elements without restricting ease of movement or creating heat discomfort and fatigue.

The potential for clothing to increase a riders' visibility to other motorists as a crash reduction strategy is less well established. However it is an issue that every rider needs to consider as failure to see the motorcyclist is a factor for up to half of the drivers who collide with motorcycles (EEVC, 1993).

The issue of fashion is not entirely trivial. One of the objectives of this project is to try to help riders distinguish between clothing features that are pure fashion and those that have some genuine protective merit. Motorcycle clothing is more functional if it is also comfortable and suitable for wear once the rider has reached their destination.

3. The injury reduction benefits of motorcycle clothing in a crash

The injury reduction potential of motorcycle protective clothing has been well established for at least 30 years (Feldkamp, et al 1976; Zettas et al, 1979; Hurt, Ouellet & Wager, 1981; Schuller et al., 1982 & 1986; Otte & Middelhauve, 1987; Hell & Lob, 1993; Otte et al 2002; ACEM, 2004).

Over 20 years ago, Schuller reported that injured riders, who had been wearing leathers, spent on average 7 days less in hospital, and returned to work 20 days earlier than unprotected riders. The protected riders were 40% less likely to have suffered permanent physical defect. It was concluded that protective clothing can prevent or reduce 43% of injuries to soft tissue and 63% of deep and extensive injuries (Schuller et al, 1986). More recently, Otte found that impact protectors reduced the incidence of complex leg fractures and reported significant injury reduction for riders wearing high boots (Otte et al, 2002).

Most research has described the injury reduction benefits of protective clothing in relation to soft tissue injuries. Protective clothing has also been found to prevent or reduce injuries such as cuts and abrasions, exhaust pipe burns, friction burns and the stripping away of skin and muscle. Protective clothing may also reduce the risk of infection from wound contamination and consequent complications in the healing of severe injuries. (e.g. Schuller et al, 1986, Pegg & Mayze, (1983) Otte & Middelhauve, 1987; Hell & Lob, 1993).

There are, of course, limits to the extent that clothing can prevent injury, particularly in high impact crashes, however there is also evidence that most motorcycle crashes are not high impact. The European Experimental Vehicles Committee's review of research into motorcycle accidents, found that the majority of motorcycle collisions take place at fairly low speeds, the average impact being at between 30 and 45 kilometers per hour (EEVC, 1993). According to the recent MAIDS (Motorcycle Accident In depth Study), 75% of all motorcycle crashes occur at speeds of 50 km/h (35 mph) or less (ACEM, 2004).

Crashes where the rider slides along the road surface without impacting a fixed object are less likely to result in severe injuries and are the types of crashes where protective clothing can offer the greatest injury reduction (Hell & Lob, 1993, Otte et al, 1987).

MAIDS reported that some 40% of riders tumbled, rolled or slid along the road from the point of the crash without any further impact with another object (ACEM, 2004).

The prevention or reduction of minor soft tissue injuries is not a trivial benefit. Overall,

almost half (49%) of all the injuries recorded in MAIDS were rated to be minor or Level 1 on the Abbreviated Injury Scale (AIS 1)[1].

Table 1 shows the severity of the most serious injury suffered by each of the riders in the MAIDS study. The most serious injury suffered by 39% of riders was rated as minor or AIS Level 1. These are the injuries that protective clothing may have prevented or reduced.

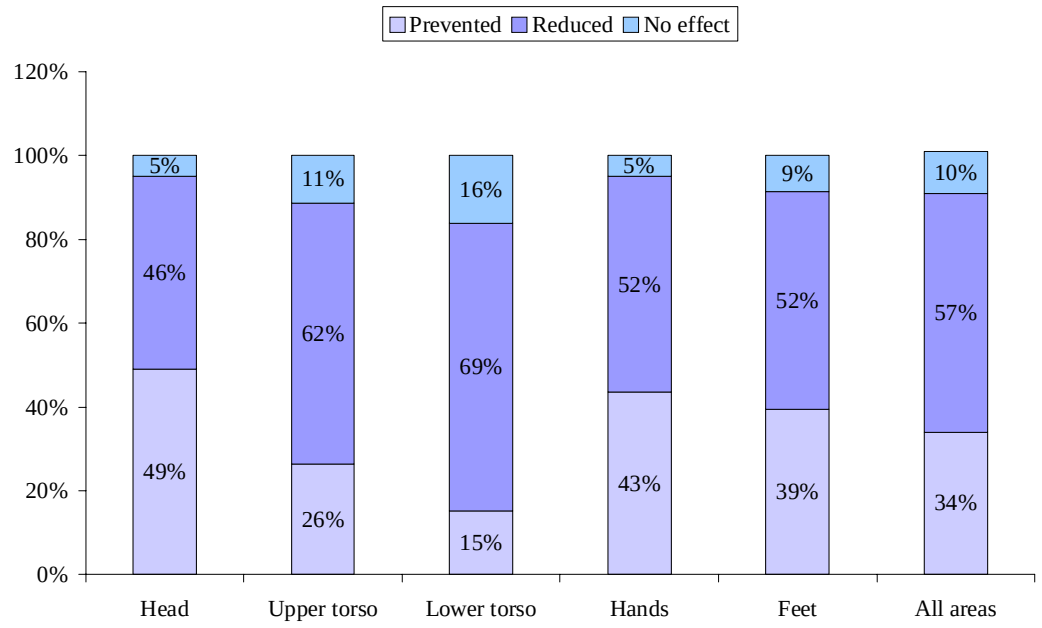
Table 1 Maximum injury severity per rider, (MAIDS, 2004)

Severity AIS Level	No injury 0	Minor 1	Moderate	Serious 3	Severe 4	Critical 5	Not Survivable 6
Proportion of riders	2%	39%	33%	16%	4%	5%	2%

The figures in Table 1 include all riders, many of whom were wearing protective clothing. The MAIDS investigators tried to establish whether clothing had reduced or prevented the incidence of AIS Level 1, minor injuries such as cuts, gravel rash, friction burns etc.

Figure 1 illustrates the proportion of riders considered to have been protected from minor injury by their clothing. The graph includes only those riders who were wearing protective clothing and sustained a direct impact that could have caused an injury to that part of the body. For example, the column for the lower torso indicates that clothing prevented minor soft tissue injury for 15% and reduced such injuries for over two thirds (69%) of these riders. Only 16% sustained minor soft tissue injuries to the legs and lower torso despite their clothing. This does not preclude those riders from also suffering some more severe injury such as a fracture, but it does mean they were less likely to have complications such as blood loss or infection from open wounds.

Figure 1. Riders protected from minor injury by clothing.

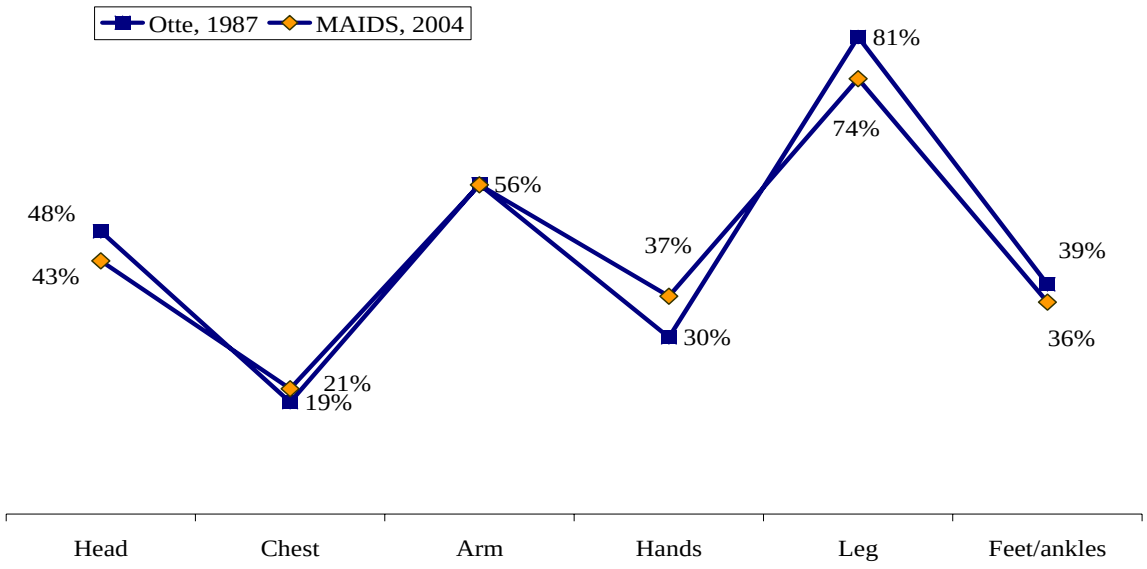


[1] On the Abbreviated Injury Scale (AIS) a 0 indicates Un-injured and 6 is Not survivable.

The parts of the body that are most frequently injured in crashes are a well established pattern. In 1993, the European Experimental Vehicles Committee (EEVC) recognized that, while head injuries account for 80% of fatalities, the legs are the area most frequently injured in a motorcycle crash (EEVC, 1993). Similar patterns of injury by body part have been documented by a range of crash studies studies in USA, UK and Germany (Hurt et al, 1981; Craig et al, 1983; Schuller et al, 1986; Otte & Middelhauve, 1987).

Figure 2 illustrates the distribution of rider injuries in 1987 (Otte & Middelhauve, 1987) compared to the recent MAID Study (ACEM, 2004). It reveals a remarkably consistent pattern despite changes in vehicle and equipment safety in the intervening decades.

Figure 2. Motorcycle injury patterns 1987 vs 2004.

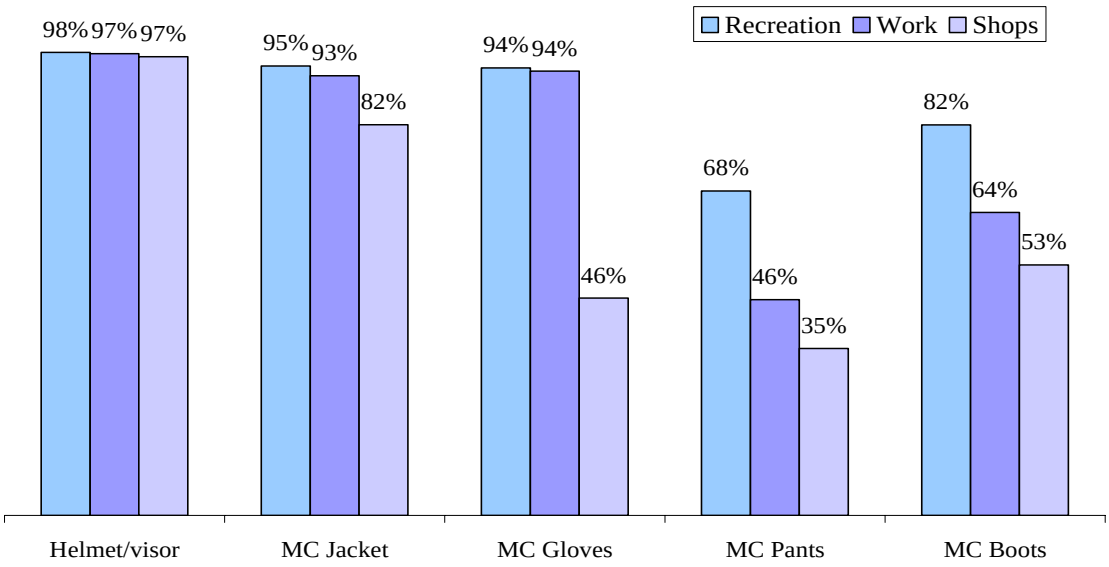


3. Rider usage of protective clothing

Australian surveys of riders' choice of clothing suggest that their decisions do not reflect awareness of the patterns of injury risk that are so well known to researchers (de Rome et al, 2004; de Rome, 2006).

In 2006, a survey of 1,300 Australian motorcyclists asked riders to choose from a list, the protective clothing items they wore the last time they: went on a recreational ride; rode to work; and went on a short trip to the local shops.

Figure 3. Riders usage of motorcycle protective clothing, 2006.



The results found that while virtually all riders wear a helmet and motorcycle jacket, they were least likely to wear protective clothing on their legs.[2] While it was not unexpected to find that many riders did not wear full gear when going on a short trip to the local shops, it was interesting to note that they were more likely to wear full gear when on a recreational ride than when riding to work. Only 64% wore motorcycle boots when commuting to work compared to 82% on recreational rides. Only 46% wore motorcycle pants to work compared to 68% when on recreational rides. They were also almost half as likely to wear pants with leg armour when commuting (17% vs 32%).

The question is whether the differences reflect choices driven by fashion or function. Do these riders believe that they have a greater need of protection on recreational rides than when they are commuting to work? Is the use of protective clothing on recreational rides more of a fashion statement to look the part?

Conversely could the reduced use of protective clothing when commuting be due to a perception of lower risk or to the need for clothing that is more appropriate to be worn in

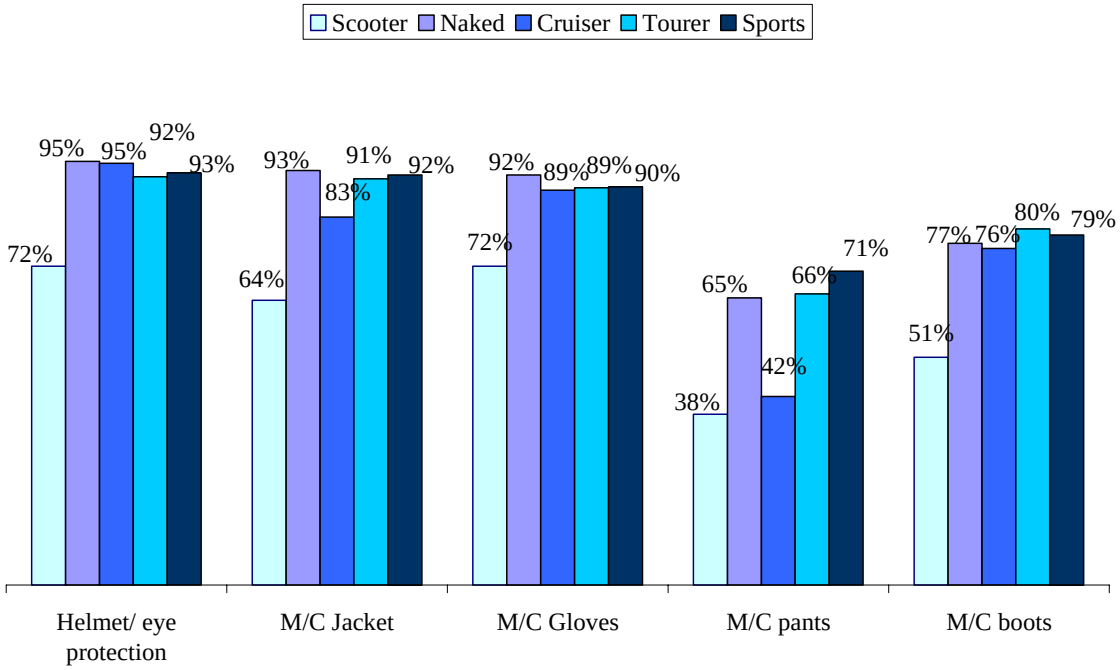
[2] The wearing of an approved, properly fastened helmet is mandatory for motorcycle riders in all states in Australia.

the workplace? Protective clothing is often stylistically inappropriate or uncomfortable for general day wear once the rider has arrived at their destination.

The pattern of usage also varied with the class of motorcycle ridden. Scooter and cruiser riders were least likely to wear high levels of protective clothing. Where high level of protection is defined as helmet with eye protection, motorcycle specific gloves and boots, and motorcycle jackets and pants with impact protectors (Unpublished data, de Rome, 2006). Riders of sports, tourer and naked motorcycles had the highest levels of protection.

Figure 4 shows the proportion of riders by class of motorcycle and whether they wore high levels of protection to each part of their body when on recreational rides.

Figure 4. Protective clothing worn on last recreational ride.



Cruiser riders were most likely not to wear motorcycle pants and were also less likely to wear a motorcycle jacket with impact protectors compared to other riders with the exception of scooter riders.

While there were only 39 scooter riders in the sample, the pattern of their usage is consistent with other work (de Rome et al, 2003). Scooter riders were most likely to wear an open face helmet without visor or goggles. They were also least likely to wear motorcycle protective pants or boots.

This is perfectly understandable in the fashion sense, because scooters are promoted by the industry as machines that do not require the rider to wear protective clothing. For examples, see magazine editorial photographs and advertisements for (e.g. Bolwell, Honda, Hawk) in Two Wheels Scooter, 2005. However we have found no evidence that scooter riders have a lower crash risk than other classes of motorcycle.

The reasons other riders do not wear appropriate protection, particularly on their legs is less clear. However, it may also be linked to the different images associated with different styles of motorcycle. Motorcycle clothing tends to be designed to suit particular

styles of motorcycle and therefore specific sectors of the motorcycle market.

An informal review of advertisements for motorcycle apparel in Australia suggests that the motorcycle clothing market is segmented for different styles of road riding. Clothing that is promoted as providing injury protection tends to be styled in the image of the race track and is aimed at sports bike riders. Clothing that provides protection from the elements tends to be touring oriented. There is relatively little motorcycle protective clothing that is suitable in terms of fashion or convenience for general road riders, cruisers, commuters or scooter riders (de Rome & Stanford, 2006).

4. Comfort and protection from the elements as a safety issue

Protection from the weather is a significant safety issue. Physical stress due to heat, cold or discomfort is tiring and distracting. A relaxed alert rider is less likely to be involved in a crash than someone who is numbed by cold, fatigued by heat or distracted by discomfort.

Cold stress

Feeling cold can affect a motorcyclist in three crucial ways. The most obvious is a loss of feeling in the hands and feet that affects the rider's ability to operate the controls. Feeling cold or uncomfortable is also stressful and tiring, which may place the rider more at risk of crashing because they are less alert and reactions may be slowed. Finally there is evidence that a rider's lower core temperature may affect decision making and increase emotional responses such as anxiety, irritability, aggressiveness, or detachment (Woods, 1986).

Insulation and wind proofing are the keys to avoiding cold stress. The principle of insulation is to allow a thick layer of air between the rider's body and the outer layer of clothing. Close fitting openings (neck, wrists and waist) and covered zippers and other fastening points prevent wind entry and heat loss and are essential to maintain the warmth of the air layer. Clothing that is too loose may also result in heat loss from wind buffeting that forces the warm air out.

A third of the body's heat is lost from the neck and face area, but these areas can be protected by the use of a full face helmet with a visor and a neck sock. Insulated boots and gloves can keep the warmth in the feet and hands. However, this will not be enough if the body is cold, because the brain will restrict blood flow to the extremities in an effort to maintain core temperature. If a rider's body is cold, then their hands and feet will also be cold. The shins of a rider are very exposed to cold; if the shins become cold this will affect blood flow to the feet and therefore the warmth of their feet. Numb feet can seriously affect the rider's capacity to operate controls.

Cold stress can also result from wind chill when wearing damp clothes, because, as the wind evaporates the moisture, it draws the heat from the body.

Wet stress

In addition to being uncomfortable, wet clothing can rapidly chill a rider because it draws heat away from the body. Water conducts heat much faster than air, which means a rider will get cold, much quicker if they are also wet. Wet clothing is a particular problem for motorcyclists because of the additional effects of the wind chill factor. The wind chill factor means that for every 5 km/h wind speed, the surface temperature drops 5 degrees.

Leather does not provide good rain protection because it absorbs water. Most modern textile suits do have some water proof or water resistant properties, however riders usually need to add another layer to be protected from rain.

Wet weather gear is essential, but riders also need to be aware that rain is not the only source of wet stress. Clothing that is wet from perspiration will also draw heat away from the body.

The key to keeping comfortably dry is to have waterproof breathable clothing. Lightweight roll up PVC or plasticised nylon over-suits are waterproof, but not breathable. This means that although they keep the rain out, they quickly become very uncomfortable because they keep perspiration in. This causes accelerated heat transfer resulting in overheating in hot weather and rapid cooling in cold weather.

Heat stress

Many motorcyclists choose not to wear protective clothing in hot weather because it can be hot and uncomfortable. However, in addition to the injury risk to exposed skin in a crash, uncovered skin also absorbs heat directly from the sun causing dehydration leading to fatigue as well as sunburn.

Protective clothing can be designed to overcome some of these problems. Just as insulation is the key to avoiding cold stress, ventilated cover is the key to avoiding heat stress. The idea is to allow wind to flow through the clothing over the skin to evaporate sweat. Air entry points though vents or mesh panels should be on the forward facing parts of the body with maximum air pressure, but should not compromise impact protection.

Light coloured outer layers of clothing can also be selected that will reflect rather than absorb infra-red heat from the road surface.

Noise or vibration stress

Noise and vibration can also cause stress resulting in fatigue and distraction for motorcyclists. Sustained noise over 90db (A) can result in permanent hearing damage, as well as minor pain which is very tiring. In one study, a researcher found that 27% of riders reported noise stress and 22% reported vibration stress (Robertson & Porter, 1987).

Protective equipment can assist to reduce noise stress. The fit and design of helmets and visors can reduce or increase the noise produced by airflow around the head. Ear plugs can also be used to reduce noise provided that they do not also reduce the rider's awareness of their riding environment. Clothing should be chosen that will not flap or vibrate in the air stream while riding, particularly near the head. There are also some boots and gloves in the market which provide protection from vibration though gel or foam in the areas in direct contact with the motorcycle.

Discomfort Stress

It is a basic requirement of all protective clothing is that it should provide a degree of protection without interfering with the rider's ability to ride safely. Riding is an athletic pursuit, so clothing must move freely with the body. The weight, flexibility, temperature control and fit of clothing can all contribute to making the rider more or less comfortable. Protective clothing should fit without constriction. If it is too tight, it may constrict blood flow causing numbness. This is particularly important for the feet, wrists and hands.

Even with the best gear, riding places a strain on the body which must be managed to maintain alertness. Sitting in the same position with limited movement for extended periods of time is unnatural and can lead to muscle stiffness resulting in discomfort, fatigue and loss of concentration. Riders should be encouraged to take regular breaks during long journeys to stretch and revive to avoid fatigue.

5. Conspicuity – drawing the attention of other drivers

In a survey of NSW drivers, 55% reported having at least one experience of having seen a motorcyclist only at the last minute when they were changing lanes. What is more worrying is that only 6% of these same drivers nominated changing lanes as a time when they should watch out for motorcycles (Benton, 2002).

Research into motorcycle crashes shows that the other driver is at fault in about 70% of motorcycle crashes with other vehicles (RTA, 2002). In many of these crashes the driver will say they simply didn't see the motorcycle until it was too late. (SMIDSY - Sorry Mate I Didn't See You).

The situation may be getting worse. In the past, the driving landscape was made up of 95% cars and station wagons. Vulnerable road users such as pedestrians, cyclists and motorcyclists stood out as they were head and shoulders above the roof line of most traffic. The increasing proportion of taller vehicles (e.g SUVs) has changed the driving landscape so that it is harder to see and be seen across traffic.

There is some evidence that what a rider wears can make a difference some of the time although the evidence from different studies suggests that this is highly dependent on the visual environment. The rider needs to be within the other driver's line of vision and the clothing must stand out against the background.

A summary of European research into safety measures for motorcyclists concluded that florescent clothing is effective during daylight, but not against a bright background. They also found that retroflective clothing gives little improvement at night (Noordzij et al, 2001).

A recent New Zealand study, found that riders wearing any reflective or fluorescent clothing had a 37% lower risk than other riders. Riders wearing white helmets had a 24% lower risk than those wearing black helmets (Wells et al, 2004). The latter may also be due to the association with police motorcyclists who wear white helmets in New Zealand.

Failure to see the motorcyclists was the primary contributing factor in 37% of all motorcycle crashes investigated in the MAID Study (ACEM, 2004). Although the researchers found no apparent contribution of garments to the conspicuity of the rider in 65% of crashes, they did report that dull or dark clothing may have decreased conspicuity in 13% of cases.

6. Standards for motorcycle protective clothing

A review of the literature found little objective information that riders could apply in selecting protective clothing products. Riders are largely dependent on the advertising claims of manufacturers or product reviews by magazines. Until recently there was no means of providing an objective assessment or comparison of the likely protective performance of any motorcycle clothing products.

The situation has changed with the development of standards for motorcycle protective clothing in Europe. Under European law, any clothing claiming to provide protection from injury must be tested and labeled as complying with the relevant standard.

This is a general European law that requires standards for all safety equipment not just for motorcycle apparel. Under the directive, a product can only be described as "protective" if it provides protection from injury, the term cannot be applied to products that provide protection from the weather.

The European Directive on Personal Protective Equipment was made law in 1989, but it took some time for the standards for motorcycle clothing to be developed. The first standard to be issued for motorcycle gear was for impact protectors, which was released in 1997 (EN 1621-1). Standards have since been issued for gloves, boots, jackets and pants and back protectors. Each has a different number and clothing that complies must have been tested and labeled with the CE mark and the appropriate standards number.

The development of the standards has provided objective tests for measuring the protective performance of motorcycle clothing products. The tests are largely based on the work of Roderick I. Woods who published a specification for motorcycle protective clothing in which he defined the injury risk and protection requirements for each part of the body (Woods, 1996). See figure 5.

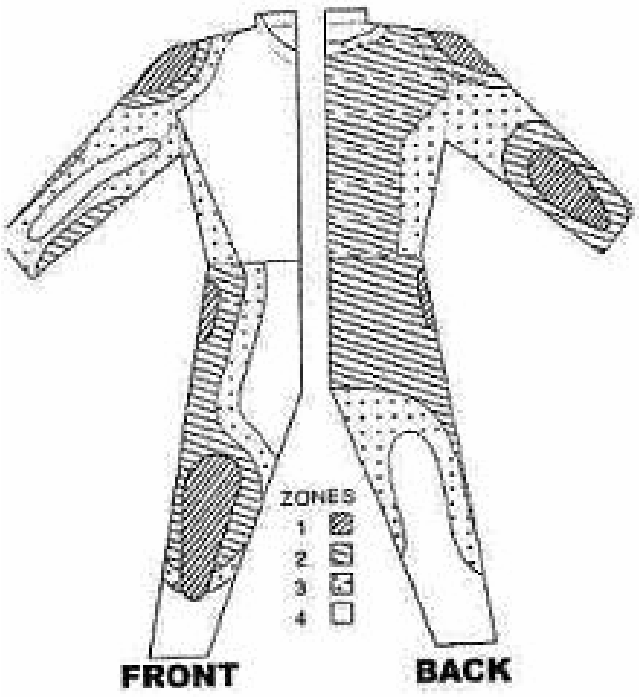
Figure 5. Injury risk zones (Woods, 1996)

Zone 1 High - needs impact protectors & high abrasion resistance

Zone 2. High - needs high abrasion resistance

Zone 3. Moderate - moderate abrasion resistance

Zone 4 Relatively low risk.



The Standards specify the test process and equipment upon which they must be performed. The tests measure performance in relation to:

1. Abrasion resistance to determine how long the material will last when being abraded against the road surface.
2. Burst strength to ensure that seams, fastenings and the material itself will not split open on impact.

3. Tear and cut resistance, required to ensure the material cannot be cut, penetrated or torn by sharp objects in a crash.
4. Impact resistance is required to slow down the rate of transfer of forces in an impact. Protection is required over specified high impact areas of the body and must remain in place during an impact.

While these standards are only enforceable in Europe, their development has significant implications for non-European markets. For the first time consumers have a means of objectively assessing how individual products would perform in the ultimate test of a crash. Applied by independent consumer organizations, the outcome has been to reveal serious failings in the safety performance of many of the products currently available in the European market.

For example, in one study of 18 leather suits tested by the British magazine "Ride" in August 2004, 7 of the suits scored 5 or less out of 10 for abrasion, 10 suits scored 5 or less on the burst test, 9 scored 5 or less on the impact test, 8 scored 5 or less on the tear test and 2 had zip failure (Crick, 2004 b).

None of these failings could have been reliably predicted by visual inspection or reliance on brand name. The results indicate that neither brand name nor cost can be used as indicators of protective quality. The most expensive suit from a world renowned company was rated second last in the rankings, whereas one of the cheapest suits was rated third best. Comparable tests of textile jackets, gloves and boots have also found the majority of those products do not perform well (Crick, 2004 a, 2004 c & 2005).

Similar independent tests have been conducted by consumer groups in the UK over the past ten years. From a comparison of such tests, over the intervening period, it is apparent that manufacturers have responded to calls for better protection. Most European manufacturers now include CE Standard impact protectors over the knees, hips, elbows and shoulders. Cotton padding or comfort foam is no longer acceptable.

The abrasion resistance scores, particularly for textile jackets, have improved significantly over time as new materials and new methods of construction have emerged. However, quality of construction remains a weak point and many of the tested suits (leather and textile) continue to fail on seam strength and material burst resistance. The frustration is that the results suggest that, in many cases, only relatively minor adjustment to production methods could achieve compliance and produce protective products that are fit for the purpose.

The absence of any equivalent standards outside of Europe mean that motorcycle protective clothing can be sold in other markets without a requirement, nor any means, to justify claims of providing protection from injury. Given the high level of failure of reputable European products when tested against the European standards, there is no reason to assume that products by other manufacturers would perform any better.

It is perhaps unrealistic to expect the motorcycle apparel industry to take a lead in raising standards for their products in the absence of demand from their markets. Consumers have been largely uninformed and undemanding, perhaps because the major source of information for riders is through motorcycle magazines, which are dependent on advertising for their revenue.

In Australia and New Zealand a number of steps have been taken to address these issues. Web based consumer guides on motorcycle protective clothing have been developed to enable riders to make more informed purchasing decisions and to demand assurances on the protective quality of the gear they buy (de Rome, 2002; de Rome, 2004).

Strategies have also been undertaken to inform the local motorcycle apparel industry about the existence of the European standards and the implications for the local industry. The availability of the standards also has implications for traders' duty of care under Australian consumer protection law (Trade Practices Act, 1974). Under this law traders can be held liable if their goods are not fit for the purpose for which they were sold.

7. Conclusion

We know which parts of the body are most likely to be injured in a motorcycle crash. We know that perhaps half of all motorcycle injuries could have been reduced or prevented by the use of effective protective clothing. We also know how to manufacture motorcycle clothing that will provide some protection to prevent or reduce injuries. There are standards and objective tests that can be used to ensure the protective performance of motorcycle clothing. Consumer confidence in the performance of these products is essential if riders are to be encouraged to invest in protective motorcycle clothing. A quality assurance or standards system independently assessed or monitored by consumer protection agencies will be essential if that confidence is to be achieved. The adoption of the European Standards as international standards could regularize the industry and provide certainty for manufacturers and motorcyclists alike.

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