HEAD RESTRAINT POSITIONING STUDY

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TABLE OF CONTENTS

EXECUTIVE SUMMARY i

INTRODUCTION **1**
Scope of Engagement 1

REVIEW OF THE LITERATURE 2
Whiplash Incidence and Severity 2
The Role of Head Restraints in Reducing Whiplash 3
What Constitutes Correct Head Restraint Geometry and Adjustment 5
Field Studies of Actual Head Restraint Adjustment 7
Additional Variables Impacting Proper Adjustment 10
Sex 10
Age 11
Regionality 12
Vehicle Type 12
Head Restraint Type 13
Occupant Position 14

STUDY METHODOLOGY 16

PRESENTATION OF STUDY RESULTS 21
Driver Characteristics and Adjustment 23
Regional Differences 25
Head Restraint Type 26
Head Restraint Position 27
Gender 28
Age 29
Vehicle Type 30
Passengers 32

SUMMARY AND CONCLUSIONS 37
DRIVERS 37
PASSENGERS 37

LIMITATIONS 39

EXTENSIONS.. 41

REFERENCES 42

APPENDICES

1. Coding Sheet
2. Scoring Protocol
3. Vehicle Coding Guidelines
4. Codes for Vehicle Make, Type and Model
5. Vehicle Registrations by Province for 2000
6. Regional Crosstabs

EXECUTIVE SUMMARY

Whiplash is a major component of the cost of insurance. Studies have shown that the extent and severity of whiplash can be reduced by proper head restraint adjustment. Proper head restraint adjustment depends on first, the design of head restraints and second, drivers and passengers making the necessary adjustments. The purpose of this study is to assess the level of proper head restraint adjustment in seven provinces in Canada. Further, information from this study could assist in designing an educational campaign to encourage better head restraint adjustment.

The study was conducted using videotape footage of drivers and passengers. Drivers (n=7571) and passengers (n=1090) were filmed in the provinces of British Columbia, Alberta, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland during the months of June and July, 2002. Drivers and passengers captured on film were rated as to where the top of the head restraint was relative to the head (vertical adjustment) and the distance between the back of the head and the front of the head restraint (backset or horizontal adjustment). Based on these measures, overall adjustment was categorized as good, marginal, poor, or very poor.

MAJOR FINDINGS FOR DRIVERS

- The study found that while only 14% of drivers had their head restraints in a good position, 46% of drivers had their head restraints at least adequately adjusted (good and marginal scores combined). These results are slightly higher than found in previous Canadian studies. Canadians appear to have significantly better adjusted head restraints than Americans.

- Head restraint adjustment was similar across all provinces of Canada except British Columbia. In BC, 55% of head restraints were adequately adjusted compared to 46% for the total sample.

- The study found little difference in the rate of adequate adjustment for both adjustable and fixed head restraints. It found that 48% of adjustable head restraints were adequately positioned compared to 43% of fixed head restraints.

- Females were almost twice as likely as males to have their head restraint adequately adjusted (61% versus 34% respectively).

- Head restraint adjustment does not appear to vary appreciably in the 20 to 59 age range.

- Drivers of large cars and light trucks were much less likely to have their head restraints adequately adjusted. Only 23% of the drivers of large cars and 22% of the drivers of light trucks (compared to 46% for the total sample) had their head restraints adequately adjusted.

MAJOR FINDINGS FOR PASSENGERS

- The study found that 60% of passengers had their head restraints adequately adjusted. This was considerably higher than for drivers (46%).

- There was little difference in the rate of adequate adjustment for both adjustable and fixed head restraints. However only 30% of adjustable head restraints were in the "up" position. This was considerably less than the results for drivers (44%).

- Consistent with drivers, this study found that female passengers were much more likely than males to have adequate head restraint adjustment (66% versus 43%). Further, head restraint adjustment did not vary appreciably with age. Finally, large cars and light trucks had the poorest rates of adequate head restraint adjustment.

INTRODUCTION

Rising insurance rates, due in large part to the rising cost of soft tissue injury, are garnering national attention (Progressive, 2002). A major element of the cost of soft tissue injury is due to whiplash sustained in rear-end collisions (Brown and Nepomuceno, 1999, Insurance Institute of Highway Safety 2001). Independent of the impact on these costs caused by differences in regulatory climate or increased fraud, it is clear that whiplash injuries are frequent, costly and, given the evidence supporting the effectiveness of head restraints, largely preventable (cf. O'Neill, 2000). As O'Neill notes in the conclusion of his review of head restraints and whiplash, "…the first basic requirement to reduce whiplash injury risk identified in the 1960s—head restraints positioned behind the head—is not being achieved today." (p. 146).

SCOPE OF ENGAGEMENT

Understanding the nature and extent of proper head restraint adjustment in Canada and its potential in reducing whiplash incidence and severity drives the current research. To contribute to this objective, the following analysis was conducted:

- Review of relevant literature to identify:

    - Incidence and costs of whiplash;
    - The ability and promise of head restraints to reduce the risk of injury;
    - The current standards concerning what constitutes the proper design characteristics or actual capability of current head restraint designs to reduce injury;
    - Studies of how drivers and passengers actually use their head restraints in normal driving conditions; and finally,
    - Occupant, vehicle and regional differences that may influence proper head restraint use.

- Interviews with experts directly involved in several aspects of the industry including the Insurance Institute for Highway Safety, National Highway Traffic and Safety Administration and the Insurance Corporation of British Columbia.

- Design and execution of an observation study of drivers and passengers, under normal driving conditions, conducted in seven provinces in Canada during June and July of 2002.

REVIEW OF THE LITERATURE

In the following section, the literature on whiplash incidence and severity is reviewed to understand the magnitude of the problem. This is followed by a review of current standards for effective head restraint position and prior studies of actual head restraint adjustment.

WHIPLASH INCIDENCE AND SEVERITY

In terms of the incidence of physical pain and suffering, whiplash injuries are not typically life threatening but according to Nygren et al (1985), about 10% of cases do result in some degree of permanent disability. Insurance Corporation of British Columbia (ICBC) data suggests that whiplash accounted for 68% of all reported injuries and of these, fully 79% were neck related (Brown and Nepomucino, 1999).

In terms of economic costs, estimates vary depending on the scope of the injury and whether societal costs are included, but amounts are universally high. In Canada, ICBC notes that while 41.3% of whiplash claims were closed without payment within twelve months, the rest of the claims accounted for 54.9% of their incurred losses (as noted in Viano and Gargan, 1995). Brown and Nepomucino (1999) have estimated that ICBC alone pays out CDN $350 million per year for neck related injuries. ICBC estimated, in a presentation to the World Congress on WAD, that whiplash costs US $135 per policy per year and that a 40% reduction in its incidence would save policyholders $54 per policy per year (Gane, 1999).

U.S. data from the Insurance Institute for Highway Safety (IIHS) suggests that neck sprains account for 66% of all insurance claims for bodily injury in the U.S. (Cullen et al. 1996). Recent IIHS figures now place the total cost of whiplash at close to US 7 billion dollars per year (IIHS, 2001). In terms of consumer impact, one estimate provided by a large U.S. insurer suggests that nearly one third of auto insurance premiums goes to coverage that pays for injuries caused by collisions, the majority of which are neck sprains (Progressive, 2002).

Given the incidence and cost of whiplash, it can be expected that the related benefits of proper head restraint adjustment would also be significant.

In Canada, Mercer and Halabisky (1999) calculated that with the current rate of head restraint use, it would take 291 head restraint adjustments to prevent one neck related injury.

THE ROLE OF HEAD RESTRAINTS IN REDUCING WHIPLASH

Although specifics very, research supporting the benefits of using head restraints has been uniformly positive (cf O'Neill et. al 1972; Kahane 1982; Viano and Gargan, 1995; Farmer et al, 1999; Pedder and Hillebrandt 2000; and Chapline et al 2000). As times have changed early studies (cf O'Neill et al 1972) which often relied on comparisons of accident rates among vehicles with head restraints to those without them, have been extended by studies in which rear-struck vehicles were examined in terms of their head restraint design and, when possible, re-constructed assessments of occupant seating position (cf Farmer et al. 1999 and Pedder and Hillebrandt 2000). A brief synopsis of prior research is included below in Table 1.

Table 1
Summary of Prior Research on
Benefits of Correct Head Restraint Adjustment

Study	***Major Findings Concerning the Benefits of Correct Head Restraint Adjustment***
Mertz and Patrick, 1967	Showed that a simulated 44 mph rear- end collision could be withstood with little discomfort if the subject's head was initially placed against a flat head restraint and the seat was rigid.
O'Neill et al, 1972	Found an 18% reduction in neck injury
States and Bacarek, 1973	Found a 14% reduction in whiplash injury
Best, 1981	Found a 17% reduction in whiplash injury for fixed restraints; 10% reduction for adjustable restraints
Kahane, 1982	Found a 13% reduction in whiplash injury: higher for fixed than for adjustable restraints
Nygren et al 1985	Found a 24.5% reduction in whiplash injury risk for fixed head restraints while adjustable head restraints reduced injury risk by 14.8%
Morris, 1989	Found that 2/3 of whiplash seen in an emergency department occurred to vehicles without head restraints while such vehicles only represented 1/3 of the vehicles on the road

Study	*Major Findings Concerning the Benefits of Correct Head Restraint Adjustment*
Olsson et al, 1990	Found more serious injuries when head restraints were > 10cm (4 inches) from the back of the head than when much closer
Svensson (1993)	After rear end collision sled tests, concluded that much smaller angular displacements of the dummy's head occurred when the horizontal distance was 4 cm rather than the current standard of 10 cm.
Viano and Gargan, 1995)	Found a 28% reduction in risk of whiplash injury if head restraints are correctly adjusted
Farmer et al (1999)	Of drivers of rear struck vehicles with good restraints (RCAR protocol), 22% claimed neck injuries while of drivers of vehicles with poor restraints, 27% claimed neck injuries.
	Overall, drivers of cars with good rated head restraints were 24% less likely than drivers with poor rated head restraints to suffer neck injuries when involved in rear-end collisions.
Gane (1999)	Found fewer injuries in cars rated as having good restraints in both tort and no-fault jurisdictions compared to cars having poor restraints.
Chapline et al (2000)	Although finding stronger results for women than men, concluded that individuals at risk of injury can reduce their risk by more than 40% with adequately positioned head restraints.

It can be seen from these results that head restraints have the potential to dramatically reduce the incidence, severity and ultimately the cost of rear-end collision, neck-related soft tissue injuries. Two subsidiary issues are therefore relevant. First, the vehicles involved in the collisions must be capable of being properly adjusted and second, drivers and passengers must make the necessary adjustments. These issues are addressed next.

What Constitutes Correct Head Restraint Geometry and Adjustment

For the past number of years, head restraint geometry has been studied using the Head Restraint Measuring Device (HRMD) designed for the Insurance Corporation of British Columbia. This device and the associated standards of height and back-set are currently used by the Insurance Institute for Highway Safety (IIHS), the National Highway Traffic and Safety Administration (NHTSA) and the Research Council for Automotive Repairs (RCAR).

Historically, head restraint design capabilities have scored very poorly. In fact, only in the IIHS tests conducted using the HRMD in 2001 did the majority of vehicles hit the acceptable/good level (IIHS News Release, October 4, 2001). Previous results of combined acceptable/good head restraint ratings were 7% (1995), 12% (1997) and 32% (1999). Clearly, manufacturer designs have improved the capability of proper head restraint adjustment. All things being considered therefore, current studies of head restraint adjustment such as the one conducted here, should illustrate this improved design capability in terms of the rate of correctly adjusted head restraints.

What constitutes correct adjustment has evolved as additional research has been conducted. These standards have direct implications for the current study as they form the criteria by which proper adjustment is measured.

Initially, when U.S. FMVSS 202 (Head Restraint) regulations were first passed, requirements were imposed on front outboard seating positions only with a height requirement of 27.5 inches from the H point (NHTSA 2000). From that point until now, research by a variety of sources has created the need to raise the minimum vertical height to 31.5 inches, permit locking, mandate outboard head restraints in rear seats and specify a maximum back set.

In terms of height requirements, current RCAR protocols require that the top of the head restraint be no lower than 6 cm down from the top of the head to be classified as “good” while anything that is more than10 cm is classified as “poor.”

Other researchers (cf Farmer et al 1999) recommend that the head restraint should be as high as the top of the head for the average size male. Similarly, Progressive (2002) advise their clients that the top of the head restraint should be at least as high as the top of the head.

Cullen et al (1996), suggest that the optimal position is such that the centre of the head restraint is positioned directly behind the head's centre of gravity. Given that the head's centre of gravity is thought to just above the top of the ear, an easily observable anatomical feature appropriate for gauging vertical adjustment relative to the head's centre of gravity is the ear.

Other researchers have also used a visual reference to the ear in their observation studies. Viano and Gargan (1995) for instance, scored the vertical adjustment of head restraints "high" if they were above the ear, "low" if they were below the chin and "medium" if they were in between. Lubin and Sehmer (1993) required that the top of the head restraint be at least as high as the vertical midpoint of the head for it to be classed as properly adjusted.

Based on these protocols and the advantages and disadvantages of the definitions used in prior studies as they pertain to observational methods, the following ratings were used in the current study. We rated vertical head restraint adjustments "good" if they were above the ear (and therefore no more than 10 cm below the top of the head), "poor" if they were level with the ear and "very poor" if they were below the ear. These criteria conform to the definitions used in a number of previous studies. Additionally, because criteria are based on reference to the ear, which is a relatively easily observed feature, accurate and consistent rating is enhanced.

In terms of backset, research by Olsson et al (1990) and Svensson et al (1993) has progressively reduced the advisable backset from 10 cm (4 inches) to a maximum of 5 cm (2 inches). As noted by the NHTSA in its notice of proposed changes to FMVSS 202, advocates argue that most head restraint designs permit too much backset and that this should be limited to "considerably" less than four inches (Docket No. NHTSA-2000-8570). In response to these views, NHTSA has proposed to add a requirement that head restraints must have a backset of less than 50 mm (2 inches) at any adjustment point. Furthermore, the NHTSA go on to note that the upper limit of "acceptable" backset is 100 mm (four inches).

For these reasons, and to be consistent with the current proposals by the NHTSA, the maximum backset used in our study for a "good" rating is 2 inches (assessed by reference to the width of the occupant's ear). A "marginal" rating was given for backsets greater than two inches but no more than four inches (assessed in our study by reference to half the anterior-posterior diameter of the head (cf Viano and Gargan, 1995; Lubin and Sehmer, 1993). Backsets greater than half the diameter of the head, but less than a full head, were rated “poor” and head restraints that had a backset greater than a full head’s diameter were rated “very poor.”

FIELD STUDIES OF ACTUAL HEAD RESTRAINT ADJUSTMENT

In the previous section, it was pointed out that the ability of head restraints to be properly positioned has increased. Research was also reviewed that specified what constitutes correct and incorrect adjustment. Yet, fundamentally, while design capability is a necessary condition for reducing injuries, it is not sufficient. What are also needed are changes to the awareness, attitudes and behaviors of drivers and passengers with respect to head restraint usage. That is, regardless of the design capabilities, a minimum level of risk will likely remain unless motorists become more knowledgeable. As noted by Lubin and Sehmer (1993), the presence of a head restraint does not mean that it is being used effectively. This section documents prior research on the nature and extent of the way people actually use their head restraints in normal driving conditions.

The majority of studies have been conducted in the U.S. Studies of actual adjustment include the work of O’Neill et al (1972), Selbring (1984), Viano and Gargan (1995), NHTSA (1996), Farmer et al (1999) and Chapline et al (2000). Canadian studies include the work of Lubin and Sehmer (1993) and Pedder and Hillebrandt (2000), both conducted in western Canada. British work includes the work of Parkin et al (1993). Cullen et al (1996) studied both U.S. and British drivers/passengers.

Beginning with the work conducted in the U.S., O’Neill et al (1972) observed drivers in 4,983 moving domestic passenger vehicles in Los Angeles and Washington D.C. They found that there were differences in adjustment between males and females and between overall adjustment in the two regions. Within Los Angeles, 43% of women had their head restraints adjusted properly while only 26% of men had proper head restraint adjustment. In Washington, overall results were lower but women again had greater adjustment than men (20% versus 7%).

Viano and Gargan (1995) studied IIHS video tape footage of 1,915 cars approaching an intersection. They found that only 10% of occupants had their head restraint in the most favorable position (males 6.1% and females 14.8%).

In a small scale study conducted by the NHTSA in 1996, 282 vehicles were observed. Of these, 59% of the adjustable head restraints were at or above the ear.

Chapline et al (2000) studied cars involved in rear end crashes. After the accident, arrangements were made to interview the drivers and to have them sit in their vehicles so that measurements could be taken of their head restraint adjustment. The protocol used by the IIHS was followed with respect to the determination of whether a head restraint was adequately adjusted. Backset was only analyzed if the drivers had adequate vertical position (the head restraint 10 cm or less below the top of the head). They found that 11% of men had adequately positioned head restraints and that women with adequately adjusted head restraints were less likely to report neck pain (29%) then women with poorly adjusted head restraints (52%).

Farmer et al (1999) found that fully 98% of the claims in their study involved cars which had the top of the unadjusted head restraint more than 9 cm below the top of the head (below the centre of gravity). They note that when head restraints are this low, they no longer stop the rearward motion of the head, but instead can act as a fulcrum for it.

Cullen et al (1996) in their cross national study found that 88% of U.K. passengers, 97% of U.S. drivers and 91% of U.S. passengers had their restraint positioned below the optimal vertical position (defined as the centre of the head restraint being level with the centre point of the back of the occupant’s head). Horizontally, they found that 24% of U.K. passengers, 40% of U.S. drivers and 31% of U.S. passengers had the restraint positioned more than 10 cm away from the back of the head.

Parkin et al (1993) in their U.K. study, found that 50% of their drivers had too much backset (defined as greater than or equal to 15 cm) and 95% had the head restraint too low (defined as the centre of the head restraint level with the centre of the back of the head). Fully 50% of the sample had the head restraint more than 10 cm (4 inches) below the centre of the head (note that RCAR standards specify that even head restraints more than 10 cm below the top of the head are rated as poor).

Turning to Canadian results, two studies have been conducted. Both studies showed better adjustment than many of those conducted elsewhere. Lubin and Sehmer (1993) found that 40% of adjustable and 67% of fixed restraints were correctly positioned. Overall, they found that 46.3% of drivers had properly adjusted head restraints. Criteria to determine proper adjustment included that the head restraint should come at least up to the vertical mid-point of the skull with a maximum backset no greater than half the anterior-posterior diameter of the skull.

Pedder and Hillebrandt (2000) found that 20.8% of head restraints were no more than 7 cm horizontally from the back of the subject's head (a "good" rating using ICBC protocols). Vertically, 37.8% of all head restraints were less than or equal to 10 cm down from the top of the head (combining ICBC "good," "acceptable" and "marginal" vertical separations).

In conclusion, it can be seen that overall head restraint adjustment under normal driving conditions is lower than desirable. It should also be noted that an understanding of how adjustment is operationalized is also necessary. Finally, and worth noting for present purposes, it can be seen that Canadian results have been relatively stronger that those found elsewhere.

In the next section, attention is turned to a variety of occupant, geographic and vehicle characteristics that impact proper head restraint adjustment.

ADDITIONAL VARIABLES IMPACTING PROPER ADJUSTMENT

Several occupant characteristics have been found to influence proper head restraint adjustment. To date, occupant position (driver versus passenger), age and sex have been studied to determine their influence on proper adjustment as has head restraint type (adjustable versus fixed); region of the country; and vehicle type (small, medium and large wheel bases as classified by the Highway Loss Data Institute).

➢ SEX

The sex of the occupant is related to whiplash in several ways. First, females are consistently more likely to have properly adjusted head restraints than males, often in a ratio of 2:1 or better. This occurs in general (that is, including both vertical and horizontal requirements as per the work of O'Neill et al.1972 and Viano and Gargan 1995) and in particular, vertically (cf the work of Chapline et al. 2000, Lubin and Sehmer 1993, Farmer et al 1999).

As noted by Cullen et al (1996), better vertical adjustment is likely due to stature differences between males and females as illustrated by Pheasant (1988) who reports a difference in sitting height of 60 mm between males and females at the 50th percentile.

Females are also more likely to report neck injury than males (cf Chapline et al 2000, Farmer et al 1999, Temming and Zobel 1998). Chapline and colleagues found that females were 1.54 times more likely to claim neck injury following an accident. Females are also therefore more likely to benefit from improvements in head restraint improvements (cf. Chapline et al 2000, O'Neill et al 1972, States and Bacarek 1973 and Farmer et al 1999).

Given these results and the strong relationship that gender has on a variety of whiplash related issues, the sex of the drivers and passengers in the current study was recorded.

- **AGE**

It is unclear the role that age plays in whiplash. In terms of actual adjustment, results are varied. Cullen et al (1996) found that occupant age was significant in effecting vertical head restraint positions for passengers in the U.K. such that older occupants were more likely to have proper vertical adjustment than younger occupants, but this relationship did not hold for either drivers or passengers in the U.S.

They speculate that when it does occur, it may be due to stature differences (Pheasant 1988) that increase as people age, noting that the stature of people between 65-80 is less than that of 19-45 year olds by 60 mm (for males) and 45 mm (for females). This in turn, should lead to older people sitting lower in their vehicles and consequently having better vertical adjustment.

Cullen et al (1996) also found that older occupants (in the U.S.) were more likely to sit further from the head restraint horizontally (no age difference was found in either the U.S. or U.K. passenger samples).

When it comes to claiming behavior, results continue to be mixed. On the one hand, Farmer et al (1999), consistent with previous studies by Maag et al (1993) and Simpson (1996), found that as people aged, they were significantly less likely to claim injury when involved in collisions. Farmer et al (1999) note that in both tort and add-on states, 32% of those aged less than 65 filed a claim while only 13% of those over 65 filed a claim. These results were similar in relationship, but not in magnitude, in Michigan.

The NHTSA on the other hand, in their report on the Identification of Issues Relevant to the Regulation, Design and Effectiveness of Head Restraints, report that the incidence of whiplash injury increases as people age (NHTSA 1995). The rates are 27.5% for people aged 15-35, 32.6% for those aged 35-54 and finally, 34.4% for those aged 55 and up.

In their study of drivers, Progressive Insurance noted a number of age differences. For instance, 49% of 18-24 year olds say they adjust their head restraint after someone has driven their car while only 36% of those aged 55-64 report doing so. Similarly, 33% of the younger age group adjust their head restraints before long trips compared to 28% of the older group.

Given these findings, it is difficult to predict the relationship between age and whiplash with respect to head restraint adjustment or claiming behavior. Nevertheless, given these findings, it is important to continue to study any relationship between age and whiplash sensitivity and head restraint adjustment. For that reason, age was recorded in the current study.

➢ REGIONALITY

Few studies of regional differences have been conducted but of those that have been done, significant influences have been found. In their original work comparing adjustment of head restraints in Los Angeles and Washington, O'Neill et al (1972) found head restraints to be significantly better adjusted on the west coast than in Washington, D.C. (more than a 2:1 ratio of proper adjustment for both males and females). As well, work conducted by a group of insurers in western Canada found that the rate of head restraint adjustment in British Columbia (which has a history of head restraint intervention campaigns) was almost twice the rates found in either Manitoba or Saskatchewan (Gane 1999). Finally, in the only trans-national study, Cullen et al (1996) noted a number of differences in how drivers/passengers scored in terms of their head restraint adjustment depending on whether they were in the U.K. or the U.S.

For these reasons, although the causes may not be known in advance, it is possible that regional differences exist. A large sampling of provinces within Canada was therefore chosen for the current study.

- **VEHICLE TYPE**

Two vehicle characteristics have been identified in the literature related to head restraint adjustment. They are the number of doors and the length of the wheel base.

With respect to the number of doors, Cullen et al (1996) found that five door models were more likely to have (in the U.S.) reduced vertical and horizontal adjustment than three door models.

With respect to size, Cullen et al (1996) found that U.S. drivers and passengers alike had worse vertical and horizontal adjustment in larger cars. Chapline et al (2000) found that vehicle size was only related to injury risk among female occupants.

To the extent possible then, vehicle type, make and model were assessed in the current study to determine whether any such relationships exist in our sample.

- **HEAD RESTRAINT TYPE**

Research has been conclusive that fixed head restraints reduce the risk of injury more than do adjustable head restraints (cf Best 1981, Kahane 1982 and Nygren 1986). This is clearly related to the fact that motorists have been historically unlikely to adjust their adjustable head restraints and to the fact that the design capability of these adjustable head restraints has been poor.

The overall ratio of adjustable to fixed head restraints is close to three to one. The NHTSA found 77% of the head restraints in their small sample were adjustable (of which 53% were adjusted); Spelbring (1984) found 70% of all head restraints were adjustable but only 30% of them were adjusted; Viano and Gargan found 73% of their head restraints were adjustable but only 25% of these were in the "up" position; and finally, Chapline et al (2000) found the rate of adjustable head restraints was 75% for males and 82% for females. Males had a 30% adjustment rate while females had 20% of their head restraints actually adjusted up.

In Canada, Lubin and Sehmer (1993) found that 40% of the adjustable head restraints were properly positioned whereas fully 67% of fixed head restraints were properly adjusted. Pedder and Hillebrandt (2000) found that 44% of the adjustable head restraints were up. Thus, Canadian results suggest an adjustment rate of close to 40% for adjustable head restraints, greater than those reported in the U.S.

Head restraint type was recorded in the current study as well as whether or not, for those vehicles equipped with adjustable head restraints, the head restraint was adjusted up from its lowest position.

- **OCCUPANT POSITION**

Relatively little attention has been paid to head restraint adjustment among passengers in either front or back seats. This lack of attention may be due in part to two reasons. For front seat passengers, data is likely to mirror that found for drivers. For back seat passengers, the lower incidence of whiplash has likely reduced the priority for investigation.

In addition, there is likely to be a confounding influence for gender, at least in North America. That is, while the proportion of male and female drivers is roughly the same, intuition suggests that when couples and families drive together, males are more likely than females to drive. Thus, passengers may be more likely to be female. And as noted earlier, due to smaller stature, it is reasonable to predict that passengers will be more likely to have proper head restraint adjustment than drivers although the actual cause of this better adjustment may be caused by gender not occupant position.

Nevertheless, both passengers of front and rear seats were designated as subjects in the current study. It was recognized at the outset that due to lower rider-ship levels in rear seats together with a greater probability of blacked out windows in SUVs and vans, generating a sample of rear seat occupants would be a challenge.

In terms of the front seat, Cullen et al (1996) did study U.K. passengers as well as drivers and passengers in the U.S. Although not a targeted element of their analysis, their results can be analyzed for systematic differences between the two. With respect to vertical adjustment, passengers had better positioned head restraints than drivers but with respect to horizontal adjustment, U.S. drivers were better positioned than passengers. Hence, no systematic relationship appears to be present.

In their recent survey, Progressive Insurance identified one systematic difference. Drivers express a greater likelihood of adjusting their head restraints if they drive than if they ride

(Progressive 2002). Whether this intention translates into action though, is still unknown.

For the time being therefore, it is safe to conclude that little is known about the head restraint adjustment of either front or rear seat passengers.

STUDY METHODOLOGY

This study was conducted using videotape footage of drivers and passengers taken during normal driving conditions. Videotape footage has been used successfully in the past (cf. Parkin et al 1993, Viano and Gargan 1995 and Cullen et al 1996). This method has the benefit of capturing normal driving conditions that may otherwise be lost if drivers and passengers know they are being observed.

Vehicles were filmed as they approached an intersection and in stop-and-go traffic. This protocol was chosen because the majority of rear-end collisions occur at very slow speeds (Parkin et al 1993) and at intersections (Chapline et al 2000). Pedder and Hillebrandt (2000) found that only 6.4% of rear end collisions occurred at speed, the rest occurring while the vehicle was stopping, moving slowly or fully stopped. In addition to providing the most realistic driver and passenger postures at the time when the potential for whiplash is greatest, the protocol also increased the quality of the video tape footage as it permitted the researchers to zoom in on the vehicles as they passed by.

In order to achieve a regional sampling error for drivers of ±3% 19 times out of 20, a minimum of 1056 observations of drivers were collected in each region. Filming was done in seven provinces including British Columbia, Alberta, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland.

Pre-testing under a variety of conditions in urban and rural settings demonstrated that given both the quality of the film that was achievable with slow moving vehicles and the potential to pan and zoom while filming, information about drivers could be obtained by filming from the passenger side. Two filming protocols were therefore possible. Depending upon the site, researchers either filmed from the driver or passenger side. On days when filming was done from the passenger side of the vehicle, data gathering about drivers was only possible when there were no passengers present. When passengers were present, data about their head restraint adjustment was also gathered. Because the primary objective of the study was to learn about head restraint adjustment among drivers, sample sizes were based on the number of useable driver observations. The sample was therefore self-generating. No attempt was made to stratify the sample by sex of driver or vehicle type.

To ensure that a sufficient number of useable driver observations were collected in each province, researchers reviewed films at the end of each day of filming prior to moving on to the next province. Two research teams spent approximately two weeks in the field.

Sites in each province were chosen in one of two ways. In some provinces, researchers simply toured likely areas looking for three and four way stops and busy intersections that would permit the taking of film. In other provinces, researchers contacted local community policing units, explained the purpose of the study and were then given information about intersections that would be appropriate. Locations adjacent to malls were chosen in all provinces. In all but two provinces, filming was done from within the rental vehicles. Only when there were no risks of contaminating the research did teams film from outside.

Coding protocol was developed based upon the literature review provided earlier together with interviews conducted with researchers involved in prior studies of this kind. As noted in an earlier section, raters used obvious anatomical features as their basis for rating vertical and horizontal adjustment.

Vertical adjustment was rated according to whether the top of the head restraint was:

- above the ear
- at the ear, or
- below the ear

Horizontal adjustment was rated based on whether the distance between the back of the occupant's head and the front of the restraint was:

- less than or equal to an ear's width
- more than an ear's width but less than or equal to half the diameter of the head
- more than half the diameter of the head but less than or equal to the full diameter of the head
- more than the full diameter of the head

Data coding was performed by four researchers using the video tape footage played on television monitors. To ensure consistency across raters, training was conducted over two days. Training concentrated on correctly and consistently rating vertical and horizontal head restraint adjustment. Initially, raters met with the authors to review the coding protocol and to view sample footage. Raters then coded ten vehicles and their occupants using the coding sheets attached in Appendix 1. Raters worked independently and did not know the assessments given by their peers. When finished, tapes were played back and a discussion was held to review their assessments and to increase consistency.

Scoring protocols and information to assist the raters are provided in Appendices 2-4. Care was taken to explain all protocols. Additional coding protocols were developed during this phase as needed. Consistent with prior research, raters defaulted to the more favorable assessment when borderline cases arose.

Following this step, raters independently coded 24 vehicles. Inter-rater agreement was measured and an additional de-briefing conducted. Finally, raters again independently coded a new set of 25 vehicles. After determining that inter-rater agreement was sufficient, raters were assigned their regions and began coding.

In addition to training efforts to ensure acceptable levels of inter-rater agreement at the beginning of the project, inter-rater agreement was measured every day over the six-week period that the raters worked.

Inter-rater agreement was assessed in three ways. First, simple percentage of agreement between the raters was established. Second, the percent of agreement was recalculated after excluding disagreements that were caused by raters coding in adjoining categories. Thus if two raters coded an observation in adjoining categories, it was coded as an agreement. Finally, a rater agreement index (RAI) was calculated (Burry-Stock et al., 1996) which specifically accounts for the *degree of agreement* between judges.

The RAI (Rater Agreement Index) is calculated for each variable using the following formula adapted from Burry-Stock et al (1996):

$$RAI = 1 - \frac{\sum_{n=1}^{N}\sum_{m=1}^{M}\left|R_{mn} - \overline{R}_n\right|}{N(M-1)(I-1)}$$

where

N = number of subjects
M = number of raters
I = number of intervals
R_{mn} = the rating assigned by the *m*th rater to the *n*th subject
$\overline{R}_n$ = the average rating of the *n*th subject by all *m* raters

As a result of discussions during the training period, four variables were identified for ongoing follow-up to ensure appropriate levels of inter-rater agreement (six variables were used during initial training sessions). Daily checks resulted in 545 (6.2%) of the total 8729 driver and passenger ratings being checked for inter-rater agreement.

The results of the checks for inter-rater agreement are presented in Tables 2 and 3. Table 2 presents inter-rater agreement for the training period while Table 3 presents inter-rater agreement for the six weeks of data coding.

Table 2
Results of Preliminary Training for Inter-rater Agreement

Variable Name	Session	Percent Agreement	% Agree, within 1	RAI
Vertical Adjustment	First	84	100	.90
	Second	91	100	.94
Horizontal Adjustment	First	65	100	.85
	Second	81	100	.90
Age	First	76	98	.93
	Second	73	96	.89
Vehicle Type	First	75	97	.88
	Second	91	99	.96
HR Type	First	97	*	.96
	Second	95	*	.95
HR Position	First	87	*	.89
	Second	90	*	.93

* Not applicable as variables are dichotomous.

Table 3
Results of Ongoing Monitoring of Inter-rater Agreement

Variable Name	Percent Agree	% Agree, within 1	RAI
Vertical Adjustment	87	100	.96
Horizontal Adjustment	77	99	.94
Age	55	94	.92
Vehicle Type	72	96	.93

The results in both tables indicate acceptable levels of agreement among different raters. It should be noted that although the rater agreement on age is lower than on other variables, and had only 55% “agreement” in assessments conducted over the six weeks, the “RAI” and the “% agreement within 1” both indicate that the general level of agreement was quite high. If raters disagreed, they tended to at least place the individual in an adjoining category.

In addition to the above, 287 of the 545 daily checks were conducted at random as a means of also assessing quality. These random checks yielded results almost identical to the results reported above. For example, the RAI for the 287 random checks was always within .003 of the totals reported above.

PRESENTATION OF STUDY RESULTS

This section presents the results of the analysis conducted of the video tape footage. It begins with a review of the sample followed by the presentation of results for both drivers and passengers. Information on drivers and passengers is presented based upon the following categories:

- overall adjustment rates
- horizontal and vertical adjustment rates
- regional differences
- head restraint type and adjustment
- gender
- age
- vehicle type

All results for the total sample of drivers are based on weighted regional data. Data from the regions was weighted based on the number of registered vehicles weighing less than 4500 kg in each province as discussed further in Appendix 5. Detailed break-outs of further cross-tabulations are also provided in Appendix 6.

The overall sample included 7,571 useable observations of drivers and 1,090 useable observations of passengers. Driver demographics (weighted) reveal more male than female drivers (55% vs 45%), 85% of which are under 50 years of age. Vehicle characteristics show that 98% of all head restraints could be classified according to type. Of these, 85% were adjustable and 15% were fixed. Vehicle type showed that 83% of all vehicles were passenger cars (33% small cars, 43% mid-sized and 7% large). Light trucks represented 3% of all observed vehicles, vans were 7% and SUVs were 7%. Passengers were much more likely to be female (69%) than male (31%).

Turning now to specific adjustment rates, it is worth reiterating the criteria that were used in this study to determine correct adjustment. These criteria are presented in Table 4. It can be seen from the table that four overall adjustment categories are possible based upon the combined ratings of vertical and horizontal head restraint placement: good, marginal, poor and very poor.

Table 4
Criteria to Determine Overall Level of Adjustment

Vertical Adjustment	Horizontal Adjustment			
	Less than or Equal to the Ear	**More than Ear but less than ½ Head**	**More than or equal to ½ Head but less than 1 Head**	**More than or equal to 1 Head**
Above Ear	Good	Marginal	Very Poor	Very Poor
At Ear..................	Poor	Poor	Very Poor	Very Poor
Below Ear	Very Poor	Very Poor	Very Poor	Very Poor

As noted by Farmer at al (1999) and others, improper vertical placement actually causes the restraint to act as a fulcrum for the head in rear-end collisions. For that reason, unless the top of the restraint is above the ear, it can not be considered to be “good.” Furthermore, given that the most accurate anatomical indicator of the head’s centre of gravity is just above the top of the ear, any adjustment that is at, or below the ear, must be considered to be inadequate.

Assessments of horizontal adjustment were also based upon comparisons to obvious anatomical features. Consistent with the proposed NHTSA standards that backset be a maximum of two inches, head restraints could have been no further from the back of the occupant’s head than the width of the occupant’s ear in order to be rated “good.” Further, we determined combined adjustments to be “marginal” if they were less than equal to half the anterior-posterior diameter of the head horizontally as long as they were above the ear vertically.

Note that the last column in this table (horizontal backsets greater than one head width) were coded consistent with previous work (cf Chapline et al 2000) which suggests that whiplash injuries worsen as the backset increases. But for the purposes of the presentation of these results, data from the last two columns were combined into one.

To summarize, given the need for reference points to anatomical features that could be readily observed during filming, *adequate* adjustment levels in this study required that the head restraint be no lower than 10 cm down from the top of the head (above the ear) and no further back from the head than 10 cm (half the anterior-posterior diameter of the head). Adequate adjustment therefore combines good and marginal ratings from Table 4.

Driver Characteristics and Adjustment

Table 5 presents overall head restraint adjustment for the national sample of drivers. It can be seen that 46% of drivers had their head restraint adequately adjusted (combined good and marginal scores of 14% and 32% respectively). These results are higher than those found in U.S. studies but similar to other Canadian studies. Given that these prior studies used a variety of definitions for the determination of proper adjustment and were conducted over a period of many years, direct comparisons are somewhat difficult. Nevertheless, some benchmarking is possible.

Table 5
Composite Adjustment Rates for Drivers

	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Drivers n = 7571	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

Four previous studies are relevant. Within Canada, Lubin and Sehmer (1993) and Pedder and Hillebrandt (2000) both studied head restraint adjustment. Lubin and Sehmer (1993) used definitions very similar to those used in this study. To be correctly adjusted they required that the top of the restraint be at least as high as the vertical mid-point of the head (which is ≤10 cm below the top of the head) with a maximum backset of half the diameter of the head (≤10 cm). Their results showed that 46% of all drivers had adequately adjusted head restraints – the same composite adjustment found here. In addition, an unpublished study by the Whiplash Awareness and Prevention Council in Alberta (1999) using the same criteria as Lubin and Sehmer (1993) found that 39.3% of head restraints in Calgary were properly adjusted.

Pedder and Hillebrandt (2000) did not report a composite adjustment figure but found that 38% of drivers were adequately adjusted vertically (≤10 cm below the top of the head) and 48% adequately adjusted horizontally (≤10 cm backset). Results for vertical and horizontal adjustment in the current study were 50% and 83% respectively (Table 6).

Table 6
Vertical and Horizontal Adjustment Rates For Drivers

	Head Restraint Adjustment					
	Vertical			Horizontal		
	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Drivers n = 7571	50	41	9	18	65	17

These lateral adjustment rates imply that according to current RCAR protocols for horizontal adjustment (backsets = 10 cm), almost all drivers are adequately protected. But, under the proposed NHTSA guidelines that permit a maximum backset of only 2 inches, only 18% of drivers have proper horizontal adjustment. To improve whiplash injury protection, designers have to improve the capability of head restraints so that they are closer to the back of the driver's head. In addition, the vertical adjustment rates suggest that in order to further reduce whiplash injury, drivers must raise their head restraints (half are still too low).

U.S. results are significantly lower. Viano and Gargan (1995), using virtually the same definitions as those used in this study, found that only 10% of drivers were adequately adjusted.

Chapline et al (2000) in their study five years later, report higher adequate adjustment rates (Chapline et al define adequate adjustment as the combination of RCAR definitions for good, acceptable and marginal). Chapline et al's assessment of adequate adjustment is virtually the same as that used in the current study (≤10 cm down from the top of the head with a maximum backset of ≤10 cm). Although they don't report combined results for all drivers, they do report the adjustment rate for males (18%) and females (29%). These results can be compared to this study which found male adjustment to be 34% and female adjustment to be 61% (Table 13). Hence, although showing significant improvement over the results found by Viano and Gargan, these rates are still below those found in Canada.

It can be concluded therefore, that Canadian results are higher than those found in the U.S. It can also be concluded that they are higher in 2002 than they were in either 1993 or 2000. As well, it should be noted that the Lubin and Sehmer results were found in British Columbia and the Pedder and Hillebrandt results were also heavily influenced by B.C. If the results of the current study are looked at for B.C. alone, rather than nationally, the composite adjustment rate (54%) is even higher as discussed below.

REGIONAL DIFFERENCES

The data in Table 7 indicates that head restraint adjustment is remarkably similar across the different provinces. Head restraints coded adequate (i.e., good or marginal) were in the mid-40 percent range (42-48%) for all provinces but BC. For BC, 54% of head restraints were coded as adequate which is the highest of all provinces. One possible reason for this finding may be the educational interventions conducted by the ICBC over the past number of years. Consistent with this finding, Table 8 indicates that BC had the greatest percent of head restraints in the most favorable position both vertically (60%) and horizontally (21%).

Table 7
Composite Adjustment Rates by Region for Drivers

Region	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
BC	18	36	26	20	100
AB	16	28	38	19	100
ON	13	32	34	21	100
NS	12	36	39	13	100
NB	7	35	28	30	100
PE	8	35	35	23	100
NF	15	30	38	17	100
Total	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

Table 8
Vertical and Horizontal Adjustment Rates by Region for Drivers

	Head Restraint Adjustment					
	Vertical			Horizontal		
Region	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
BC	60	36	5	21	61	18
AB	46	41	13	20	65	15
ON	49	42	9	17	66	17
NS	51	44	5	15	74	11
NB	49	40	11	8	64	28
PE	45	43	13	10	72	18
NF	47	43	10	18	67	15
Total	50	41	9	18	65	17

HEAD RESTRAINT TYPE

This study found that 15% of head restraints were fixed and 85% were adjustable. This is consistent with previous studies such as those by the NHTSA (1996) which found that 23% of head restraints were fixed and 77% were adjustable. Other authors have also found similar results for adjustable head restraints: Spelbring (1984) – 70%; Viano and Gargan (1995) – 73%; Chapline et al (2000) – 75% to 82%.

The data in Table 9 indicates that 48% of all adjustable head restraints were adequately adjusted. This is consistent with Lubin and Sehmer's (1993) study of drivers in BC that found 40% of all adjustable head restraints adequately adjusted. Table 9 also indicates there is little difference in the proper positioning of fixed and adjustable head restraints, that is, 43% of fixed and 48% of adjustable head restraints were rated adequate. Lubin and Sehmer (1993) however, found a difference in positioning between fixed and adjustable head restraints. That is, while 40% of adjustable head restraints were adequately adjusted, 67% of fixed head restraints were adequately adjusted.

Table 9
Composite Adjustment Rates by Head Restraint Type for Drivers

HR Type	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Fixed	11	32	32	24	100
Adjustable	15	33	33	20	100
Total	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

The data in Table 10 supports the consistency of the results between fixed and adjustable head restraints. Both fixed and adjustable head restraints have similar vertical and horizontal positioning profiles.

Table 10
Vertical and Horizontal Adjustment Rates by Head Restraint Type for Drivers

	Head Restraint Adjustment					
	Vertical			Horizontal		
HR Type	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Fixed	49	40	11	14	64	21
Adjustable	51	41	8	19	66	16
Total	51	41	9	18	65	17

HEAD RESTRAINT POSITION

This study found that 44% of adjustable head restraints were in the up position and 56% were in the down position. These results are consistent with previous research in Canada. For example, Lubin and Sehmer (1993) found 38% of adjustable head restraints in the up position and Pedder and Hillebrandt (2000) found 44% in the up position. Research in the US on the proportion of head restraints in the up position varies: NHTSA (1996) – 53%; Viano and Gargan (1995) – 25%; Chapline et al (2000) – 20 to 30%; Spelbring (1984) – 30%. The data in Table 11 also indicates that vehicles with head restraints in the up position have dramatically better head restraint positioning. For vehicles with the head restraint in the up position, 64% were rated adequate but for those in the down position, only 34% were rated adequate.

Table 11
Composite Adjustment Rates by Head Restraint Position for Drivers

HR Position	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Up	19	45	23	13	100
Down	12	22	41	25	100

* Total might not add up to 100% due to rounding errors.

The data in Table 12, not surprisingly, indicates that head restraints in the up position were much more likely to be in the most favorable vertical position (70%) than head restraints in the down position (37%). Interestingly, vehicles with head restraints in the up position were also more likely to be in the most favorable horizontal position (22%) than vehicles in the down position (16%).

Table 12
Vertical and Horizontal Adjustment Rates by Head Restraint Position for Drivers

HR Position	Head Restraint Adjustment: Vertical			Horizontal		
	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Up	70	29	2	22	66	12
Down	37	49	14	16	65	19

GENDER

The data in Table 13 indicates that females (61%) were almost twice as likely as males (34%) to have their head restraint adequately adjusted. Although the absolute value of the percent that are positioned properly is higher than previous studies, the dramatic difference between males and females is consistent with previous studies (O'Neill (1972), for example, found that women were 1.7 to 2.9 times more likely to be positioned properly).

Table 13
Composite Adjustment Rates by Gender for Drivers

Gender	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Males	7	27	38	28	100
Females	23	38	28	11	100
Total	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

The data in Table 14 indicates that females are much more likely than males to have the head restraint positioned in the most favorable position both vertically (65% vs. 39%) and horizontally (27% vs. 10%). It has been hypothesized (Cullen et al, 1996) that differences in average height between females and males may explain some of difference in vertical adjustment for head restraints between females and males. It is not clear what may be driving the differences in the horizontal positioning.

Table 14
Vertical and Horizontal Adjustment Rates by Gender for Drivers

	Head Restraint Adjustment					
	Vertical			Horizontal		
Gender	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Males	39	48	14	10	67	23
Females	65	32	3	27	64	9
Total	50	41	9	18	65	17

AGE

The data in Table 15 indicates that for over 92% of the sample (i.e., drivers in the 20 to 59 age range), head restraint positioning does not vary appreciably. However the youngest and the oldest age groups were better adjusted than the other groups. The oldest age group (60+) had 57% of their head restraints adequately adjusted and the youngest group (16-19) had 70% of their head restraints adequately adjusted. These results are considerably better than the sample results of 46% for head restraints adequately adjusted. The data on vertical and horizontal positioning in Table 16 is consistent with these results. Some caution is warranted, however, in interpreting these results given the small sample size for the youngest group (n=49) and the fact that previous findings in the literature have been mixed with regards to age.

Table 15
Composite Adjustment Rates by Age for Drivers

Age	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
16-19 yrs.	39	31	20	10	100
20's	15	33	30	22	100
30's	13	32	34	21	100
40's	15	33	34	18	100
50's	11	30	39	21	100
60+ yrs.	19	28	28	25	100
Unsure	11	35	35	19	100
Total	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

Table 16
Vertical and Horizontal Adjustment Rates by Age for Drivers

	Head Restraint Adjustment					
	Vertical			Horizontal		
Age	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
16-19 yrs.	76	22	2	39	51	10
20's	53	39	8	18	63	19
30's	49	43	9	18	65	17
40's	51	40	9	17	69	14
50's	42	46	12	16	67	17
60+ yrs.	54	36	10	23	55	22
Unsure	50	38	12	13	73	14
Total	50	41	9	18	65	17

VEHICLE TYPE

The data in Table 17 indicates that head restraint positioning is substantially poorer for large cars and light trucks. Only 23% of large cars and 22% of light trucks were likely to have their head restraints adequately adjusted. This is considerably less than the 46% level of adequate adjustment for the total sample.

Table 17
Composite Adjustment Rates by Vehicle Type for Drivers

Vehicle Type	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Small Car	16	36	32	16	100
Medium Car	14	32	33	21	100
Large Car	6	17	38	39	100
Light Truck	4	18	38	40	100
Van	11	31	36	22	100
SUV	18	36	32	14	100
Total	14	32	33	20	100

* Total might not add up to 100% due to rounding errors.

The data in Table 18 indicates that both poor vertical and poor horizontal positioning are responsible. Large cars and light trucks were about half as likely to have their head restraints in the most favorable vertical and horizontal positions compared to all other vehicles.

Table 18
Vertical and Horizontal Adjustment Rates by Vehicle Type for Drivers

Vehicle Type	Head Restraint Adjustment					
	Vertical			Horizontal		
	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Small Car	57	39	4	21	66	14
Medium Car	49	41	9	18	66	16
Large Car	27	48	25	9	60	31
Light Truck	25	46	29	8	56	36
Van	49	44	8	14	66	21
SUV	59	36	5	20	68	12
Total	50	41	9	18	65	17

PASSENGERS

This section discusses the findings for front-seat passengers. A total of 1,090 front-seat passengers were recorded. The sample was self generating to the extent that the regions are not proportionally represented. The results presented here are not weighted and may therefore not be a true representation of the national image. However, we note that for drivers, results did not change materially when weighted. Because final sample sizes within most regions were too small to permit adequate levels of sampling error, results are presented for the total sample only.

Given a variety of difficulties coding rear-seat passengers, in particular problems caused by the roof support pillar obstructing observation, we restricted the sample to front-seat passengers.

Table 19 examines the percentage of passengers that were in one of four head restraint adjustment categories. Drawing from the data, it was found that 19% of front-seat passengers had their head restraints adjusted in a good position. A total of 60% were adequately adjusted (combined total of "good" and "marginal" categories).

Table 19
Composite Adjustment Rates for Passengers

	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total* (%)
Passenger s n = 1090	19	41	25	16	100

* Total might not add up to 100% due to rounding errors.

Comparing passengers and drivers in this study, front-seat passengers compared quite favorably. While 46% of drivers were adequately adjusted (see Table 5), 60% of front-seat passengers were adequately adjusted (Table 19). It is likely this difference is partially due to the higher percentage of females in the passenger sample (69%) compared to the driver sample (45%). As noted previously, females generally have better-quality head restraint adjustments partially due to their smaller physical stature (Cullen et al, 1996).

When examining vertical adjustment (see Table 20), 66% of front-seat passengers had their head restraint adjusted above the ear, while only 5% were in the least favorable position or below the ear. On the horizontal dimension, 21% of the sample was in the most favorable position while 14% were in the least favorable position. These numbers are similar to the female driver's findings (see Table 14).

Table 20
Vertical and Horizontal Adjustment Rates For Passengers

	Head Restraint Adjustment					
	Vertical			Horizontal		
	Above Ear (%)	Ear (%)	Below Ear (%)	Less than or Equal to Ear (%)	Less than or Equal to ½ Head (%)	Greater than ½ Head (%)
Passengers n = 1090	66	29	5	21	65	14

It would appear that there is still room for improvement in both vertical and horizontal adjustments, especially when the revised NHTSA guidelines are implemented that mandate maximum backsets of less than 2 inches. If individuals in the "less than or equal to ½ head" category could be moved to the next level, this would increase the number of individuals with good adjustment from 21% to 86%. This would be a significant improvement.

Examining the type of head restraints, 16% of front-seat passengers' head restraints were fixed while 84% were adjustable. In examining the level of adjustment, fixed head restraints were adequately adjusted 63% of the time while adjustable head restraints were in an adequate position 59% of the time (see Table 21).

Table 21
Composite Adjustment Rates by Head Restraint Type for Passengers

HR Type	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total (n =)
Fixed	19	44	21	16	166
Adjustable	19	40	25	16	879
Total	19	41	25	16	1045

This finding is inconsistent with previous research in which fixed head restraints have been found to be significantly better than adjustable head restraints (c.f. Best, 1981; Kahane, 1982; Lubin and Sehmer, 1993).

When examining adjustable head restraints only, 30% were found in an "up" position (see Table 22). This is less than the 44% of head restraints in the "up" position for drivers. For front-seat passengers, head restraints in the "up" position were better adjusted: 26% were in the good position compared to 15% for head restraints in the "down" position. A large difference was found when the "good" and "marginal" categories were combined. A total of 74% in the "up" compared to 52% in the "down" position were adequately adjusted.

Table 22
Composite Adjustment Rates by Head Restraint Position for Passengers

HR Position	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total (n =)
Up	26	48	14	12	252
Down	15	37	30	18	597

In the sample, approximately 69% of passengers were females (n=741). Table 23 shows that females had head restraint adjustments that were, on average, better than males. A total of 67% of females had an adequate level of adjustment while only 43% of males achieved this ranking. Importantly, one in four males was in the least favorable position while, conversely, only one in ten females was in this category. Once again, this is consistent with the literature that has found females have better-quality head restraint adjustments (Cullen et al, 1996).

Table 23
Composite Adjustment Rates by Gender for Passengers

Gender	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total (n =)
Males	15	28	32	26	329
Females	21	46	22	11	741
Total	19	41	25	16	1070

Similar to the findings for drivers, the various age categories do not appear to be dissimilar on head restraint adjustment for front-seat passengers (see Table 24). Young passengers did have slightly better scores but small sample sizes once again should be noted (n=69). However, passengers when compared to similarly aged drivers do have better head restraint scores. Once again, this might be a function of gender differences between the two samples.

Table 24
Composite Adjustment Rates by Age for Passengers

Age	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total (n =)
Under 16 yrs.	33	45	3	19	69
16-19 yrs.	20	49	12	19	69
20's	15	38	31	17	335
30's	15	36	32	16	188
40's	21	39	28	13	183
50's	20	39	24	17	108
60+ yrs.	21	52	13	13	128
Total	19	41	25	16	1080

Consistent with the driver results found earlier in the report, "Large Car" and "Light Truck" vehicle types had the least favorable head restraint adjustment scores for front-seat passengers (see Table 25). Large cars were poor with only 35% attaining an adequate rating. Passengers in light trucks were the second worst; 54% of passengers were adequately adjusted.

Table 25
Composite Adjustment Rates by Vehicle Type for Passengers

Vehicle Type	Head Restraint Adjustment				
	Good (%)	Marginal (%)	Poor (%)	Very Poor (%)	Total (n =)
Small Car	21	42	25	12	435
Medium Car	16	43	26	15	394
Large Car	14	21	29	36	93
Light Truck	10	44	27	20	41
Van	26	56	11	7	55
SUV	28	29	24	19	58
Total	19	41	25	16	1076

Vans scored well with 82% of passengers having adequately adjusted head restraints. This is a much better result than van drivers who registered a 42% “good” or “Marginal” rating (see Table 17). But because of a very small sample size (n=55) for van passengers, no conclusions should be drawn without further study.

SUMMARY AND CONCLUSIONS

DRIVERS

This study found that while 46% of drivers had their head restraints "adequately" adjusted (good and marginal scores combined), only 14% of drivers had their head restraints in a good position. These results, though slightly higher, are consistent with previous Canadian studies but they are significantly higher than US results. Head restraint adjustment was similar across all provinces of Canada except British Columbia. In BC, 55% of head restraints were adequately adjusted compared to 46% for the total sample. We hypothesize that the improvement from previous Canadian studies may be due to recent improvements in head restraint design. Further we hypothesize that the better BC results may be due to the educational interventions undertaken by the ICBC.

This study found that 85% of head restraints were adjustable and 15% of head restraints were fixed. Further, this study found little difference in the rate of adequate adjustment for both adjustable and fixed head restraints. We found that 48% of adjustable head restraints were adequately positioned compared to 43% of fixed head restraints. We also noted that for adjustable head restraints, 44% were in the up position.

Our study also gathered information on factors hypothesized to correlate with proper head restraint adjustment. We found that females were almost twice as likely as males to have their head restraint adequately adjusted (61% versus 34% respectively). In addition, head restraint adjustment does not appear to vary appreciably in the 20 to 59 age range. Finally, we found that large cars and light trucks were much less likely to have their head restraints adequately adjusted. Only 23% of large cars and 22% of light trucks compared to 46% for the total sample had their head restraints adequately adjusted.

PASSENGERS

This study found that 60% of passengers had their head restraints adequately adjusted which was considerably higher than for drivers (46%). There was little difference in the rate of adequate adjustment for both adjustable and fixed head restraints. However only 30% of adjustable head restraints were in the "up" position, which is considerably less than the results for drivers (44%). We therefore hypothesize that the higher percentage of female passengers (69%)

compared to female drivers (45%) may be responsible for the improved rate of adjustment.

Finally, consistent with drivers, this study found:

- Female passengers were much more likely than males to have adequate head restraint adjustment (66% versus 43%).

- Head restraint adjustment does not vary appreciably with age.

- Large cars and light trucks had the poorest rates of adequate head restraint adjustment.

LIMITATIONS

This study has a number of limitations which are discussed next. The first limitation is the extent to which the sample reflects a national perspective. As noted, although the sample was drawn from seven different provinces, no data was gathered in Saskatchewan, Manitoba or Quebec. For these reasons, the study can't claim to be truly national in scope.

A second limitation has to do with the inability to acquire a large enough sample of observations of rear-seat passengers. Although this was not a primary objective of the study, it had been hoped that a large enough sample would be generated to permit analysis. It is apparent that a different methodology is needed to learn about rear-seat passengers.

A third limitation was the inability to explicitly distinguish between head restraint adjustment in rural and urban areas. Although this could be approximated by looking at highly urbanized provinces versus Atlantic provinces, the approximation would be tenuous inasmuch as sampling even in Atlantic Canada was done in urban areas to ensure the field work was maximally efficient.

Fourth, filming was done adjacent to malls. These drivers may not be representative of all drivers in a particular province. For example, perhaps the percentage of female drivers in the sample is overstated. While analysis of adjustment for males and females would not therefore be affected, it is possible that overall results may be skewed to females. If so, the effect is likely to be a modest over-statement in proper adjustment rates.

A fifth limitation of this report pertains to the analysis rather than the study in total. The inability to accurately assess vehicle make, model and year poses a number of restrictions on the type of analyses that could be conducted. Although a sufficiently large sample of vehicles was drawn with identifiable license plate numbers, without corresponding V.I.N. data, accurate assessments of make, model and year were not possible. This in turn prevented an assessment of the degree to which vehicles that were capable of being properly adjusted (design) actually were adjusted. What *was* learned was the proportion of *all* vehicles which had properly adjusted head restraints regardless of whether they were actually capable of being adjusted. As well, without license plate data, it is impossible to know whether the adjustment rates are increasing by model year although we predict that this must be so given the IIHS ratings discussed earlier. It may be that actual adjustment rates in late model cars is already very high. If so, any interventions may be more effective if specifically targeted at owners of earlier models.

A sixth limitation, and one that also pertains to the analysis, is the lack of complex modeling of multi-variate interactions. That is, while the impact on adjustment has been examined for each of sex, age, vehicle type, etc., interactions among these variables has not been conducted.

Finally, a seventh limitation is the potential for measurement error due to the use of an observational study relying on references to anatomical features gathered with zoom lenses that panned the vehicle as it moved past the research team. Alternative methodologies, such as using a static camera angle (cf Parkin et al 1993), or those that physically measure drivers' actual adjustment while stopped were not used for a variety of methodological and logistical reasons.

The methodology employed by Parkin et al (1993), which used static camera angles from perpendicular vantage points, and which works well for air bag studies, was not used because it poses complications for head restraint studies. This is because the "B" pillar of the car typically obstructs the ability to actually see the back of the head and the front of the head restraint. The need to therefore reconstruct the ergonomic features of the head in order to approximate the distance to the head restraint, using manufacturer provided information about the width of the "B" pillar, poses its own set of constraints.

Reconstructing "natural" driving postures among drivers who are asked to participate in a study and are then asked to sit "normally," also poses complications. When observed, drivers and passengers alike may adopt postures that do not accurately reflect their postures when unobserved.

For these reasons, the methodology used here was adopted. Although significant precedent exists for the methodology, which when combined with the need to gather large amounts of data from multiple regions of the country, support its use, it is possible that measurement error may be modestly higher with this method than with other methods.

EXTENSIONS

Several extensions to this study are possible and are identified here.

First, using data already collected, the addition of V.I.N. data would permit several additional sets of analyses as noted above.

Second, given the information gathered in this report, it is possible to perform a cost-benefit analysis of the benefits of doing educational interventions on a regional and national basis.

Third, it is possible to design an intervention study that permits the research team to interview drivers thereby allowing the team to also assess rear-seat passenger head restraint adjustment. During the interview process, driver and passenger awareness and attitudes toward head restraint purpose and use could also be assessed.

Fourth, more sophisticated modeling beyond the scope of this document could be conducted to further explore the relationships among variables.

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1. Coding Sheet
2. Scoring Protocol
3. Vehicle Coding Guidelines
4. Codes for Vehicle Make, Type and Model
5. Vehicle Registrations by Province for 2000
6. Regional Crosstabs

Appendix 1 Coding Sheet

Car #	Coder	Region	Car Action	Vehicle Type	Occ. Position	North/South	East/West	H.R. Type	Up/Down	Sex	Age	Loose Obj.
	1 MC 2 HC 3 AL 4 KL	1 BC 2 AB 3 ON 4 NS 5 NB 6 PE 7 NF	1 Brake 2 Stop Go 3 Lo Sp 4 At Sp	Type = Make = Model = # Doors 1 2-Door 2 4-Door	1 Driver 2 F Pass 3 R Pass D 4 R Pass P 5 R Pass C	1 Abv Ear 2 Ear 3 Bel Ear 4 Unsure	1 <Ear 2 <½ Head 3 ½, 1 Head 4 >1 Head 5 Unsure	1 Fix 2 Adj. 3 Unsure	1 N.A. 2 Up 3 Down 4 Unsure	1 Male 2 Female 3 Unsure	1 <16 2 16-19 3 20’s 4 30’s 5 40’s 6 50’s 7 60+ 8 Unsure	1 Yes 2 No 3 Unsure

Car #	Coder	Region	Car Action	Vehicle Type	Occ. Position	North/South	East/West	H.R. Type	Up/Down	Sex	Age	Loose Obj.
	1 MC 2 HC 3 AL 4 KL	1 BC 2 AB 3 ON 4 NS 5 NB 6 PE 7 NF	1 Brake 2 Stop Go 3 Lo Sp 4 At Sp	Type = Make = Model = # Doors 1 2-Door 2 4-Door	1 Driver 2 F Pass 3 R Pass D 4 R Pass P 5 R Pass C	1 Abv Ear 2 Ear 3 Bel Ear 4 Unsure	1 <Ear 2 <½ Head 3 ½, 1 Head 4 >1 Head 5 Unsure	1 Fix 2 Adj. 3 Unsure	1 N.A. 2 Up 3 Down 4 Unsure	1 Male 2 Female 3 Unsure	1 <16 2 16-19 3 20’s 4 30’s 5 40’s 6 50’s 7 60+ 8 Unsure	1 Yes 2 No 3 Unsure

Car #	Coder	Region	Car Action	Vehicle Type	Occ. Position	North/South	East/West	H.R. Type	Up/Down	Sex	Age	Loose Obj.
	1 MC 2 HC 3 AL 4 KL	1 BC 2 AB 3 ON 4 NS 5 NB 6 PE 7 NF	1 Brake 2 Stop Go 3 Lo Sp 4 At Sp	Type = Make = Model = # Doors 1 2-Door 2 4-Door	1 Driver 2 F Pass 3 R Pass D 4 R Pass P 5 R Pass C	1 Abv Ear 2 Ear 3 Bel Ear 4 Unsure	1 <Ear 2 <½ Head 3 ½, 1 Head 4 >1 Head 5 Unsure	1 Fix 2 Adj. 3 Unsure	1 N.A. 2 Up 3 Down 4 Unsure	1 Male 2 Female 3 Unsure	1 <16 2 16-19 3 20’s 4 30’s 5 40’s 6 50’s 7 60+ 8 Unsure	1 Yes 2 No 3 Unsure

Car #	Coder	Region	Car Action	Vehicle Type	Occ. Position	North/South	East/West	H.R. Type	Up/Down	Sex	Age	Loose Obj.
	1 MC 2 HC 3 AL 4 KL	1 BC 2 AB 3 ON 4 NS 5 NB 6 PE 7 NF	1 Brake 2 Stop Go 3 Lo Sp 4 At Sp	Type = Make = Model = # Doors 1 2-Door 2 4-Door	1 Driver 2 F Pass 3 R Pass D 4 R Pass P 5 R Pass C	1 Abv Ear 2 Ear 3 Bel Ear 4 Unsure	1 <Ear 2 <½ Head 3 ½, 1 Head 4 >1 Head 5 Unsure	1 Fix 2 Adj. 3 Unsure	1 N.A. 2 Up 3 Down 4 Unsure	1 Male 2 Female 3 Unsure	1 <16 2 16-19 3 20’s 4 30’s 5 40’s 6 50’s 7 60+ 8 Unsure	1 Yes 2 No 3 Unsure

APPENDIX 2

SCORING PROTOCOL

The following list contains the guidelines that were created and used by the researchers while coding the data for the Head Restraint Study. This protocol is necessary to ensure consistency in coding.

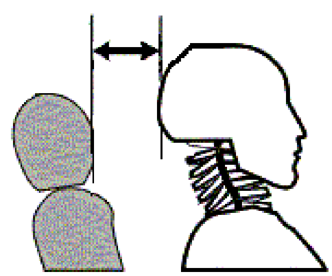
- N/S Variables:

  (#1) – Higher than the top of the ear
  (#2) – Lower than or equal to the top of the ear, and higher than or equal to the bottom of the ear
  (#3) – Lower than the bottom of the ear
  (#4) – Unable to accurately determine the N/S variable

- E/W Variables:

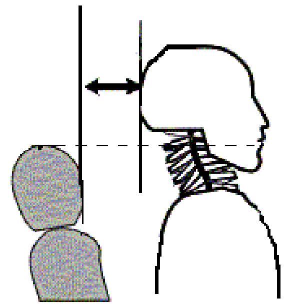
  (#1) – Less than or equal to an ear width
  (#2) – Greater than an ear width, but less than or equal to half a head width
  (#3) – Greater than half a head width, but less than or equal to a head width
  (#4) – Greater than a head width
  (#5) – Unable to accurately determine the E/W variable

- The E/W variable is measured from the western most point of the head to the eastern most point of the head restraint. (See Diagram)



- If the head restraint is below the chin, then the E/W variable automatically gets a failed score of > 1 Head (#4).

- If the headrest is below the bottom of the ear, but higher than the chin, then the E/W variable is measured using the plane of the head restraint. (See Diagram)



- If the measurement is difficult to determine and the coder must decide between two scores (i.e. #2 or #3), the lower or “better” score is always given.

- If the coder is deciding between two different ages, the lower age is always given.

- If the Make and Model of a vehicle is unknown, to determine Vehicle Type, the Ford manufacturer guide of small, mid-size and full-size vehicles is used as a guide.

APPENDIX 3

VEHICLE CODING GUIDELINES

- will consist of three separate variables, arranged in the following order: **Type- Make- Model**.

- Coding for the *Type* variable will coincide with the vehicle category:

  Small - 1
  Mid-Size - 2
  Full-Size - 3
  Light Truck - 4
  Van - 5
  SUV - 6

- Coding for the *Make* variable will coincide with the car vendor. For example, Ford will be labeled as 1, Mercury will be labeled as 2, Volvo will be labeled as 3 and so forth.

- Coding for the *Model* variable will coincide with the brand of vehicle. For example, Focus will be labeled 1, while an Escort will be labeled a 2.

- If the researcher is unsure of the *Make* or *Model*, the variable will be coded as a **0**.

- If the researcher encounters a *Make* or *Model* that is not presently listed, then the variable will be coded with a **99**.

Example	**Code**
i. Ford Ranger	Type - 4 Make - 1 Model - 1
ii. Chevy Cavalier	Type - 1 Make -8 Model - 3
iii. BMW Z3	Type - 1 Make - 27 Model - 3

APPENDIX 4

CODES FOR VEHICLE MAKE, TYPE AND MODEL

FORD MOTORS

1. Ford

Type	Model
1. Small	1. Focus 2. Escort 3. ZX2 4. Thunderbird
2. Mid-Size	1. Mustang 2. Focus Wagon
3. Full-Size	1. Crown Victoria 2. Taurus 3. Taurus Wagon
4. Light Truck	1. Ranger
5. Van	1. Windstar
6. SUV	1. Escape 2. Explorer 3. Explorer Sport Trac 4. Expedition 5. Excursion

2. Mercury

Type	Model
1. Small	
2. Mid-Size	1. Cougar
3. Full-Size	1. Grand Marquis 2. Sable 3. Sable Wagon
4. Light Truck	N/A
5. Van	1. Villager
6. SUV	1. Mountaineer

3. **Volvo**

Type	Model
1. Small	1. S40
2. Mid-Size	1. S60 2. Cross Country 3. V40 4. V70
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	N/A

4. **Mazda**

Type	Model
1. Small	1. Protégé 2. Protégé5
2. Mid-Size	1. 626 2. Millenia
3. Full-Size	
4. Light Truck	1. Mazda Truck
5. Van	1. MPV
6. SUV	1. Tribute

5. **Chrysler**

Type	Model
1. Small	1. PT Cruiser
2. Mid-Size	1. Sebring
3. Full-Size	1. 300M 2. Concorde
4. Light Truck	N/A
5. Van	1. Town & Country 2. Voyager
6. SUV	1. Jeep Wrangler 2. Jeep Liberty 3. Jeep Grand Cherokee

6. **Dodge**

Type	Model
1. Small	1. Neon
2. Mid-Size	1. Stratus 2. Stratus Sedan
3. Full-Size	1. Intrepid
4. Light Truck	1. Dakota
5. Van	1. Caravan 2. Ram Van
6. SUV	1. Durango

7. Pontiac

Type	Model
1. Small	
2. Mid-Size	1. Firebird 2. Vibe 3. Grand AM 4. Sunfire
3. Full-Size	1. Bonneville 2. Grand Prix
4. Light Truck	N/A
5. Van	1. Montana
6. SUV	1. Aztec

8. Chevrolet

Type	Model
1. Small	2. Prizm
2. Mid-Size	1. Malibu 2. Monte Carlo 3. Cavalier 4. Camaro
3. Full-Size	1. Impala
4. Light Truck	1. S10 Pickup
5. Van	1. Astro 2. Venture
6. SUV	1. Tracker 2. Blazer 3. TrailBlazer 4. Suburban 5. Tahoe

9. Oldsmobile

Type	Model
1. Small	
2. Mid-Size	1. Aurora 2. Alero
3. Full-Size	1. Intrique
4. Light Truck	N/A
5. Van	1. Silhouette
6. SUV	1. Bravada

10. Buick

Type	Model
1. Small	N/A
2. Mid-Size	1. Century
3. Full-Size	1. LeSabre 2. Park Avenue 3. Regal
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Rendezvous

11. GMC

Type	Model
1. Small	N/A
2. Mid-Size	N/A
3. Full-Size	N/A
4. Light Truck	1. Sonoma 2. Sierra
5. Van	1. Safari 2. Savana
6. SUV	1. Envoy 2. Jimmy 3. Yukon 4. Yukon Denali 5. Yukon XL

AMERICAN HONDA MOTORS

12. Honda

Type	Model
1. Small	1. Civic Coupe 2. Civic Si 3. Insight 4. S2000
2. Mid-Size	1. Accord 2. Accord Sedan 3. Civic Sedan
3. Full-Size	
4. Light Truck	N/A
5. Van	1. Odyssey
6. SUV	1. CR-V 2. Passport 3. Pilot

13. Acura

Type	Model
1. Small	1. CL 2. RSX 3. . 4. NSX
2. Mid-Size	1. TL
3. Full-Size	1. RL
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. MDX

Hyundai Motor Group

14. Hyundai

Type	Model
1. Small	1. Accent 2. Tiburon 3. Elantra
2. Mid-Size	1. Sonata 2. XG350
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Santa Fe

15. KIA

Type	Model
1. Small	1. Rio
2. Mid-Size	1. Optima 2. Rio Cinco
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Sportage

Mitsubishi Motors

16. Mitsubishi

Type	Model
1. Small	1. Eclipse 2. Lancer 3. Mirage
2. Mid-Size	1. Diamante 2. Galant
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Montero 2. Montero Sport

SATURN

17. Saturn

Type	Model
1. Small	2. SL
2. Mid-Size	1. LS 2. LW 3. SC
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Vue

NISSAN MOTOR CO.

18. Nissan

Type	Model
1. Small	1. Sentra
2. Mid-Size	1. Altima 2. Maxima
3. Full-Size	N/A
4. Light Truck	1. Frontier
5. Van	1. Quest
6. SUV	1. Pathfinder 2. Xterra 3. Murano

SUBARU

19. Subaru

Type	Model
1. Small	1. Impreza 2. Impreza Wagon
2. Mid-Size	1. Legacy 2. . 3. Legacy Wagon 4. Outback
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Forester

AMERICAN SUZUKI MOTOR CO.

20. Suzuki

Type	Model
1. Small	1. Esteem 2. Esteem Wagon
2. Mid-Size	
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. Vitara 2. Grand Vitara 3. Grand Vitara XL-7

TOYOTA

21. Toyota

Type	Model
1. Small	1. Celica 2. ECHO 3. Corolla 4. Prius
2. Mid-Size	1. Camry 2. Camry Solara 3. Matrix 4. Avalon
3. Full-Size	
4. Light Truck	1. Tacoma
5. Van	1. Sienna
6. SUV	1. RAV4 2. 4Runner 3. Highlander 4. Land Cruiser 5. Sequoia

VOLKSWAGAN

22. Volkswagan

Type	Model
1. Small	1. Golf 2. Cabrio 3. GTI 4. Jetta 5. New Beetle 6. Jetta Wagon
2. Mid-Size	1. Passat 2. . 3. Passat Wagon
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	1. Eurovan
6. SUV	N/A

DAEWOO

23. Daewoo

Type	Model
1. Small	1. Lanos 2. Nubira
2. Mid-Size	1. Leganza
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	N/A

LEXUS

24. Lexus

Type	Model
1. Small	1. IS 300
2. Mid-Size	1. ES 300 2. IS 300 SportCross
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. RX 300 2. LX 470

INFINITI

25. Infiniti

Type	Model
1. Small	1. G20
2. Mid-Size	1. G35 2. I35
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. QX4

AUDI

26. Audi

Type	Model
1. Small	1. A4
2. Mid-Size	1. A4 Avant 2. A6 Avant 3. Allroad Quattro 4. S4 Avant 5. S6 Avant
3. Full-Size	N/A
4. Light Truck	N/A
5. Van	N/A
6. SUV	N/A

BMW

27. BMW

Type	Model
1. Small	1. 2. M Coupe 3. Z3 Roadster 4. M3 Coupe
2. Mid-Size	1. 3-Series Sport Wagon 2. 3-Series
3. Full-Size	1. 745i 2. 745Li Sedan 3. 5-Series Sport Wagon
4. Light Truck	N/A
5. Van	N/A
6. SUV	1. X5

APPENDIX 5

VEHICLE REGISTRATIONS BY PROVINCE FOR 2000[1]

Province	# of Vehicles Weighing less than 4500 kgs.	Weighting
NF	241,925	2%
PE	72,559	<1
NS	518,472	4
NB	433,600	4
ON	6,443,516	54
AB	1,998,767	17
BC	2,245,015	19
Total	11,953,854	100%
Canadian Total	17,054,798	

Provinces as a percentage of Canadian total = 70%

1. Data from Table 405-0004, CANSIM II

APPENDIX 6

REGIONAL CROSSTABS

- British Columbia 1
- Alberta 11
- Ontario 22
- Nova Scotia 33
- New Brunswick 44
- Prince Edward Island 55
- Newfoundland 66

BC

AB

ON

NS

NB

PE

NF

Car #	Coder	Region	Car Action	Vehicle Type	Occ. Position	North/South	East/West	H.R. Type	Up/Down	Sex	Age	Loose Obj.
	5 MC 6 HC 7 AL 8 KL	8 BC 9 AB 10 ON 11 NS 12 NB 13 PE 14 NF	5 Brake 6 Stop Go 7 Lo Sp 8 At Sp	Type = Make = Model = # Doors 2 2-Door 2 4-Door	6 Driver 7 F Pass 8 R Pass D 9 R Pass P 10 R Pass C	5 Abv Ear 6 Ear 7 Bel Ear 8 Unsure	6 <Ear 7 <½ Head 8 ½, 1 Head 9 >1 Head 10 Unsure	4 Fix 5 Adj. 6 Unsure	5 N.A. 6 Up 7 Down 8 Unsure	4 Male 5 Female 6 Unsure	9 <16 10 16-19 11 20’s 12 30’s 13 40’s 14 50’s 15 60+ 16 Unsure	4 Yes 5 No 6 Unsure

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